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Nutrition Advisory Committee.

BY the inauguration of the Nutrition Advisory Committee, His Excellency the Viceroy has focussed public attention and enlisted the sympathy of the leaders of public life in favour of the vital problems of human and animal nutrition. In his opening speech H. E. Lord Linlithgow laid particular stress on the application of the researches of the nutrition laboratories to the food habits of the people as well as to those of animals in their service, in close collaboration with the investigations of the agricultural departments. The question of nutrition has been arousing increasing public interest in the last three decades, as a result of social and scientific progress, and the health organisation of the League of Nations has been engaged in investigating certain aspects of this subject for several years. It will be remembered that at the public session of the League Assembly in 1935, a discussion took place on the relation of nutrition to public health on the one hand and to economic and social problems on the other, resulting in the adoption of a series of resolutions urging Governments to examine the practical means of securing better nutrition. Writing on Nutrition Research in India,[1] we observed that

> "The question of feeding India for national efficiency is sufficiently important to warrant the creation of certain new departments such as the Bureau of Food Economics and the Agriculture Adjustment Board which would have to work in closer collaboration with the Nutrition Research Laboratories at Coonoor and with the Provincial Agricultural Departments. The first step is to work out a set of figures showing the amount of land that would have to be devoted to various food crops for each of the dietary plants, assuming that they will be universally used by the Indian population. These figures will naturally include not only crops used directly for human food but also crops necessary to feed the required dairy and work animals. A close

[1] *Curr. Sci.*, April 1935, **3**, 10.

relationship has thus to be established between dietary habits and agricultural practice."

We have always emphasised that the problems of public health are more intimately connected with the nutrition of the people and the agricultural policy of the State than with the prevention of diseases, and this view is in accordance with the results of medical researches which establish that most of the maladies which afflict man arise from lack of resistance produced by malnutrition. The institution of the Nutrition Advisory Board which includes experts of agricultural and veterinary science, linked up with the Scientific Advisory Board of the Indian Research Fund Association, must remove the general criticism that "the agricultural policy in India is not correlated with the science of nutrition" and must be the outcome of the recognition of the fact that the problems of public health, human and animal nutrition and of agriculture "vitally constitute the elements of a single great administrative policy".

The primary task of the Nutrition Advisory Board will be to formulate easily understood principles on which the scientific control of the production and distribution of food to the nation must be founded, and to institute a machinery for popularising these principles. For the purpose of ensuring an equable and equitable distribution of food, it may be necessary for the State to assume the responsibility of controlling the production of food in the country and its retail and wholesale distribution. The dietary change intended to be introduced is an enlightened reform of the habits and appetites of the people, and if the reason for the change is understood, there must be ready acquiescence even by those who are put to the most inconvenience. The problem of animal nutrition introduced for the first time in India, is not likely to land in the question of man *versus* animal; human food in the form of cereals and potatoes may not be employed for fattening animals to the extent of diminishing their supply for man's consumption. On the other hand, the Board ought to indicate the policy of increasing, as far as possible, the food available for man by planting more disease-free cereals, by ploughing up grass lands for wheat and rice cultivation, and by increasing the culture of potatoes. The collection of carefully tested information about nutrition understood by the average person and about dietary standards suited to different levels of income is the province of experts in land economics, who will have to compare nutritional standards and requirements, the nutritive values of common foods and the cost of their supply. The patterns of diet based on their investigations for the different classes of people and tested by the Public Health Department, should take the form of broad specifications permitting adequate room for individual family selection. It seems to us that the Nutrition Advisory Board should have included in its personnel a food economist and a physiologist whose expert knowledge and guidance are almost indispensable in dealing with the extensive and complicated programme of work undertaken.

Before the Board produces a scheme for dietary plans in relation to incomes, its investigations in India will presumably be based more or less on the lines analogous to those of the Bureau of Agricultural Economics and the Agricultural Adjustment Administration in the United States, dealing with Agricultural production and land use. The information collected by these bodies embraces the scientific results regarding the nutrition values and standards, the practical adoption of these findings into the daily meals of the people, the relation of public welfare to the people's diet and the capacity of land for producing the requisite quantity and quality of food. It ought to be the function of the food economist to investigate the family budgets and fix the prices of the different articles, and even seek for legislative sanction against stocking and for enforcing sales at non-remunerative prices. When complete and sufficiently simple and flexible plans have been prepared, the Nutrition Advisory Board has to employ all the devices of propaganda for popularising the results of their labours for national benefit.

The need of building up a physically stronger, healthier and more efficient population by means of better nutrition has been engaging the attention of Governments for the past thirty years, and that need is obviously the result of the play of forces in modern civilisation. Its problems are machinery and money, its conflicts, labour and capital, its ideals, records and impatience and its achievements, poor health and weak stomach. It should be remembered that the

alimentary system is the one organ that comes periodically into immediate contact with the environment, and when man discovered the art of cooking, he practically laid the foundation of its functional alteration. Elaborate cooking and highly seasoned food have sophisticated human appetite, which can put forth new efforts only when food is sufficiently provocative. The part that the spice trade has played in international politics during the Stuart and later times is an example of the weakened stomach produced by sauces and the stress of competitive life. The Nutrition Advisory Board might give a most scientifically correct plan containing the proper amount of calories and a requisite amount of vitamins, and if the planned food is incapable of being digested and assimilated, its labours are futile. Modern civilisation has robbed the educated community of hunger, and what induces its people to eat is the force of habit, the monotony of which they attempt to relieve by resorting to the by-lanes and footpaths of alimentation provided by the eating houses, bar rooms and restaurants. The question of food did not trouble Governments and people before the invention of machinery, and since its appearance and progress, man has devoted more time to business than to food and sleep. Before the days of the industrial revolution he ate leisurely and slept peacefully. The continuous excitement and irritation of modern civilisation have placed food and sleep under the category of mild but necessary nuisances, and modern man loves and respects his business more than food and sleep. When the human mind is agitated by endless cares and worries it must inevitably react prejudicially on the natural sources of restoration and nourishment. This agitation commences from the age of five in the case of the educated communities, and continues till old age, and under the dispensation of compulsory education, people who are happily exempt from the influences of fretful civilisation, are proposed to be deprived of the care-free and peaceful life, under which they eat well and sleep well.

The stomach of the modern educated man, in whatever station he is placed, has lost much of its natural powers which distinguished his ancestors. The progress of material civilisation, as it affects the educated communities, seems to be almost in conflict with the physical health, hardihood and efficiency which characterised the generation belonging to the early Christian era. The question of nutrition is primarily the problem of the urban population on whom the pressure of all the complicated factors of the civilisation impinges. In the villages, open air, plenty of manual exertion, simple and unsophisticated food and occasional fasting, with few opportunities for excessive indulgence, keep the peasantry healthy and robust. Even when scientists prepare perfect diets for the inhabitants of towns, there remain the causes which have tended to weaken the stomach. These causes have to be removed or mitigated before the people can be expected to benefit by the labours of the Nutrition Advisory Board. It seems to us that what profits people most is not what they eat so much as how they eat. If food is loved and respected, eaten in leisure and peace, and in company and with mirth, it is capable of nourishing the body, provided it is also simple and wholesome. Modern civilised man lacks leisure, peace, open air, exercise and appetite. His sleep is banished by the agitating cares and anxieties of his business, his stomach is weakened by food, highly seasoned to whip up a jaded appetite. Such a man needs predisgested food. The physical growth of man proceeds under the constant and contemporary influence of his mind on the stomach, and this psychological factor is frequently ignored. The psychology of modern life has to be investigated before the nation can hope to profit by the results of nutrition researches.

The progress of work achieved by the Nutrition Advisory Board will be watched with keen interest by the public and we hope that, recognising the fact that national well-being is one of the categorical imperatives, the Board will be able to suggest the practical means of securing the objects for which it was brought into existence.

August Wilhelm von Hofmann, 1818-1892.

FOR those well past the meridian of life, a glimpse of early stages in a vast enterprise may have exceptional interest, because many of the later stages have come under their own observation. To a younger generation, such glimpses come as an inspiriting suggestion that seemingly unimportant occurrences, and sometimes even failures, may carry the germs of a great discovery, or conceal the foundations of a flourishing industry. From these two points of view the admirable Hofmann Memorial Lecture, lately delivered by Professor G. T. Morgan at the Imperial College of Science and Technology, will make a wide appeal.

It was appropriate that this lecture should have been delivered at the Imperial College, and by Professor Morgan. The chemistry department of the Imperial College is the lineal descendant of the Royal College of Chemistry founded in 1845 by Hofmann, who remained there as director until he returned to Germany in 1865. Professor Morgan's first appointment was in the famous Huddersfield dye-factory of Read Holliday and Sons, and although his direct contact with dye-making was broken for twenty years, his interest in that branch remained ardent, and in 1915 he rendered valuable service to the war-time isomeride of his old firm, which had then been renamed British Dyes, Limited. As might be expected, therefore, Professor Morgan's address provides an illuminating survey of Hofmann's contributions to coal-tar colour-chemistry, and elucidates the theoretical aspect of the organic branch prevailing in the 1860's.

Delicately, and perhaps wisely, it does not decide the paternity of the aniline-dye industry. While continental chemists have claimed this for Hofmann, British chemists have recognised the agency of W. H. Perkin. If dates alone are taken as the determining factor, the latter claim has the sounder foundation, because Perkin discovered mauve in 1856, while Hofmann's first preparation of rosaniline (fuchsine) was made in 1858. Moreover, Perkin was led by his discovery without delay to manufacture the product on a commercial scale, while Hofmann continued to manufacture chemists. Thus it is that, even if Hofmann was not the father of modern dye-making, he was undoubtedly the step-father, his pupils including Perkin himself, and the brilliant, but ill-fated Mansfield, along with Nicholson, Greville Williams, Caro, Martius, O. N. Witt and Griess, names which remain illustrious in the romantic history of this remarkable industry.

Furthermore, with so much heavy material for assemblage, Professor Morgan did not speculate on the origin of the early label for rosaniline, namely fuchsine. This dye was introduced commercially in 1859 by the French firm of Renard and Frank, so that *renard* the fox may have suggested the German *Fuchs* ; alternatively, the lovely red colour of the then fashionable fuchsia may have inspired the dye-name.

Probably the general reader will find most attraction in the sections dealing with (1) the foundation of the Royal College of Chemistry in 1845, and (2) the development of Read Holliday and Sons. There is a queer element of the fortuitous in both events. In 1842 Justus von Liebig had visited England under the guidance of his former student at Giessen, Lyon Playfair, and after ample inspection of cities, and numerous contacts with bigwigs, had concluded that *England ist nicht das Land des Wissenschaftes*. Either the gibe or the contacts bestirred the natives, for the Prince Consort and the Queen's Physician, Sir James Clerk, were well supported in founding the Royal College of Chemistry, where, for the first time in England, chemistry became the main subject of study, instead of being a lowly handmaiden to medicine.

The development of Read Holliday and Sons, though free from pageantry, is more romantic. Born in 1809 at Bradford, Read Holliday began in 1830 to distil ammonia from gas-works liquor, and offered this new wool-cleanser to the manufacturers of Huddersfield, where he bought a strip of land on the river Colne and invited the local gas-works to dump its tar thereon. Thus he came to recognise the other volatile possibilities concealed by this unsavoury refuse, and in 1848 patented his naphtha-lamp, long used in gipsy-caravans and country-fairs. He became the owner of six tar-distilleries in the north of England and one in London, while Mansfield, just before his death in 1855, enabled Holliday to separate the benzenoid components in reasonable purity. The stage was now set for commercial application of Perkin's mauve, or aniline purple, discovered in

1856. The price of benzole rose to 20*s.* a gallon in 1860, when aniline was 20*s.* a pound.

Those were empirical days, and Professor Morgan's picture of Dan Dawson illuminates the period. This great Yorkshire personality was born in 1836 to a Huddersfield dyer, and his first 10 lb. of magenta, made in the kitchen-oven, not only realised £100 sterling, but coloured the succeeding loaves of bread. By 1874 he had made a fortune, and elected to study chemistry under Hofmann, whose researches had laid the foundation of his prosperity. Accordingly, in 1875 he proceeded to Berlin, while retaining association with his Yorkshire factories, Messrs. John W. Leitch and Company with the Colne Vale Dye and Chemical Company; and after returning from Germany, lectured for several years on the chemistry of coal-tar products at the Huddersfield Technical College.

Professor Morgan has laid under deep obligation all those to whom the early history and the early chemistry of artificial dye-manufacture appear momentous and engrossing. The dramatic evocation of lovely colours, beneficent drugs and agreeable perfumes from a disgusting waste-product must appeal to all who can savour the contrasts of life, and can appreciate the importance of the seemingly unimportant. In romance and enlightenment this industry remains unrivalled, while Professor Morgan brings both attributes vividly to mind.

Data on Post-Glacial Climatic Changes in North-West India.

By H. de Terra and G. E. Hutchinson.

In the course of explorations carried out in the Himalayas, in Indian Tibet and the Punjab foothills, we have come across a number of phenomena which throw some light on post-glacial climatic changes. In view of the growing interest which geologists, meteorologists and archæologists have recently shown in this problem, it seemed desirable to present our observations and to give a brief summary of the multiple evidence of subrecent climatic pulsations.

This evidence may conveniently be classified as follows :—

(1) morainic deposits lying in an intermediate position between terminal moraines of the last Pleistocene glaciation and recent moraines of existing glaciers ;

(2) terraces connected with post-glacial movements of valley glaciers ;

(3) lake terraces or raised beaches indicating high water levels ;

(4) data inferred from ancient chronicles and prehistoric monuments ;

(5) indirect data from observations on rock engravings, patination, etc.

1. Recent studies on the Pleistocene glaciation in Kashmir, which were carried out by the first author and Mr. T. T. Paterson, show that valley glaciers advanced five times, leaving distinct traces of moraines and glacio-fluvial outwash deposits in the valleys. Previously already Oestreich, and especially Dainelli, had presented proof for a complete Pleistocene glacial cycle in neighbouring areas, but only through recent work has it become possible to correlate the glacial and interglacial deposits of the mountainous tract with fossiliferous (mainly Upper Siwalik) formations in the adjoining foothills. This correlation permits of dating the second Himalayan ice-advance as being of Boulder Conglomerate or Middle Pleistocene age, so that the following third and fourth glaciations would fall into the Upper Pleistocene. The terminal moraines of the fourth glaciation were observed between 7,500 and 8,500 feet above sea-level, and in most cases the corresponding trough was appreciably smaller than the higher trough scooped out by the third glaciers. This feature already indicates a progressive weakening of the climatic changes so far as their intensity is concerned. Moreover the fifth ice advance was so weak, as compared with the fourth, that hardly any distinct new troughs were made, the glaciers having formed small ice tongues which may have looked like recent glaciers in a somewhat advanced position. That this fifth ice advance was appreciably weaker than the fourth, is clearly seen from the high position of the last terminal moraines which lie 500 to 2,000 feet higher than the moraines of the fourth glaciers. Commonly there is one terminal moraine wall, but in a few valleys there are two sets, the highest and latest of which lies only 500 feet below the recent glacier snout.

These observations make one suspect a post-glacial age for the fifth ice advance in

Kashmir. There are, moreover, other signs indicating a post-Pleistocene origin, namely:

(a) the fifth (and sixth) terminal moraines are thinner and smaller than any of the older moraines, and therefore resemble recent glacial deposits;

(b) their rock material reflects the formational composition of a small area restricted to the uppermost parts of the valleys;

(c) their state of preservation is distinctly fresher than that of the lower moraines.

These observations permit the conclusion that the fifth glaciation, as compared with the longer periods of the major ice advances, was of rather short duration.

The question arises whether there occurred one or two post-glacial climatic pessima. In the upper Liddar and in the upper Vishav valleys in Kashmir, Paterson and de Terra observed two sets of younger moraine walls below the present glacier snout. Similar conditions were observed by de Terra in Western Tibet on certain glaciers which descend towards the Sumjiling plain, east of the border pass Lanak La. The older terminal moraine here lay 1,500 ft., the younger one only 600 feet, below the glacier. Considering that these glaciers lie in perfectly graded troughs wherein the ice movement is relatively stable (as compared with glaciers in the Karakorum range), it is very probable that the two moraines represent subrecent stages of glacial retreat.

2. In Kashmir, as also in the adjoining foothill region of Poonch, the post-glacial terminal moraines are frequently associated with at least one, rarely two terraces. This terrace is composed of glacio-fluvial outwash material which was deposited during the waning stage of the valley glaciers. Within the sequence of terraces, found along most of the valleys, this terrace is the fifth and lowest, being often not more than 10 feet above the present stream level. Its gravel is banked up against a prominent slope below the fourth terrace which in itself is connected with a retreat stage of the fourth glaciers. Between the two ice advances evidently lies a long period of erosion, separating the last of the Pleistocene glaciations from the first post-glacial pessimum. Significantly enough, this fifth terrace occurs far outside of the glaciated tract, as in the Potwar and Indus valley regions, where it clearly marks a stage of valley filling, due most likely to increased water supply.

3. Evidence for post-glacial climatic changes as presented by raised beaches have been frequently cited by Hedin and other explorers. In an unpublished paper on the ecology and zoogeography of the fishes of Kashmir and Indian Tibet, the second author reports such phenomena at Lake Pangur in Western Tibet as follows:—

"Around the present shore of Pangur Tso (a few miles beyond Shushul in Ladak) there is a series of four low beaches which, lying in graded steps between 4345 m. and the present lake level at 4329 m., cut into the Pleistocene interglacial lake deposits and into the base of the alluvial fans which cover them. Beaches of this kind are very usual around the closed lakes of Indian Tibet. It is highly probable that all the closed basins experienced a period of high levels in the closing stage of the last glacial, when much water, stored as ice, must have run into their basins. While it appears that the highest post-glacial levels represent a stage at which Pangur was isolated from Panggong Tso, it is quite possible that the latter had for a time an outflow into the Tang-tse Valley at this period. But it is by no means safe to assume that all of the high beaches of post-glacial age were formed at a very remote time. It has been shown (de Terra and Hutchinson, 1934) that considerable oscillations of lake level occurred during the 19th century, a period not especially remarkable for the amplitude of its climatic changes. It is therefore highly probable that at other periods in historic and proto-historic times, oscillations of considerable magnitude have occurred."

This possibility should be kept in mind when interpreting the great number of raised beaches to be found on the shores of Lake Panggong, Mitpal and Tso Moriri in Ladak. At Mitpal Tso we observed some 16 beaches of which a greater portion seemed to be cut into old alluvial fans. Their formation is doubtless due to a progressive lowering of the lake level, but this limpies that during each successive stage the lake remained sufficiently stable for a great number of years to allow wave action to erode the shore. It is also possible that the dwindling reservoirs of snow and ice on the surrounding mountains controlled to a certain degree such changes of lake level, thus exerting a retarding influence on an otherwise more rapid process of desiccation. Future observations should therefore concentrate on a detailed study of post-glacial shore deposits in relation to raised beaches

and to the stratigraphy of deep water sediments.

Outside of the Himalayas, in the Salt Range of the North-West Punjab, are a number of lakes which lie in a region famous for its archæological records. One of these is the Son Sakesar Kahar, in the Shapur district, near the town of Naoshera. On its western end this lake is surrounded by a wide belt of salt marshes, bordered by a terrace which is four feet above the present lake level. On this were found the ruined foundations of an ancient temple-like building whose architecture suggests its having been erected during the first half of the first millennium A.D. This site still showed a number of limestone slabs lying in step-like manner on the terrace edge as if a staircase had led from the main hall to a lake shore. At present this lake shore is dry, the lake being half a mile distant from the edge of the terrace. Although the villagers admitted that the lake submerged occasionally a small portion of the salt marshes, none could recall that the water had ever extended to the ruins, where a much travelled path has led, since ancient times, across the lake basin. It is therefore very probable that at that time the lake extended to the edge of the terrace and in still older periods it must have swept the entire terrace, which is made of lake deposits. This highest level is indicated by various beach remnants found a few miles east of the village of Chitta where wave cut cliffs occur 7 feet above the present lake level of Son Sakesar Kahar. As the area belongs to one of the driest regions in North-West India, it is obvious that this raised beach must represent a period of abundant water supply.

Smaller oscillations of climate leading to the formation of beaches have occurred during the 19th century in Indian Tibet, as de Terra and Hutchinson (*Geogr. J.*, 1934) have shown. The water level of Panggong Tso fell during the first half of the century, till in 1869 it was about 5·9 m. below the level in 1932; subsequent to 1869 a rise took place, the present level probably being established some time after 1900. A very low shore line, about three meters below the lowest level of the sixties of the last century, was observed by Godwin Austen. This clearly indicates an ancient dry period.

4. The Tibetan chronicle *La-dvags-rgyal-rabs* (translation by A. H. Francke, *Archaeol. Survey of India, New Imp. Ser.*, Vol. 50, 1926) mentions from the environs of Lhasa that during the reign of Sron-Khri-lde-btsam (755–797 A. D.) floods and good harvests occurred, which would indicate a wet period, as such always correspond with fertile years in Tibet at present. Quite possibly, this humid phase is the same as the one which is recorded by a raised beach in lake Son Sakesar Kahar in the Salt Range.

Of greater interest however is the chronicle of the kings of Kashmir, *Rajatarangini*. According to A. Stein's translation it describes a vast lake which occupied the Kashmir valley. This lake was drained off by a heroic act of Khashiap who cut the mountain barrier with his magic sword, thus draining the lake towards India. One would think that this saga referred to the "Karewa lake" which existed during the Ice Age and in which the lake beds were deposited, which nowadays form the so-called "Karewas" or raised terraces. This can hardly be the case, for the Karewa lake was drained off at the beginning of the second inter-glacial, as recent studies have proved, and no human tradition is known to date back to the middle of the Ice Age. It is much more probable that the Kashmir saga refers to a great and prolonged inundation of prehistoric and post-glacial times. Such explanation is borne out by the following facts:—

(*a*) Temporary increase of water supply still leads to disastrous floods in Kashmir, and the valley is at such time transformed into chains of lakes which may occupy one-quarter of the entire valley floor. The survey maps 43*J*, 12, 13, 15, 16 amply illustrate how easily the flood plain of the Jhelum river can be inundated by heavy rainfall.

(*b*) The rigidly observed rule that ancient historic sites and prehistoric dwellings are always found on the tops of ancient river terraces or isolated hillocks in Kashmir, would indicate that a lake actually existed in the valley, flooding all outlets of subsidiary streams as well as portions of the central valley floor. A megalithic monument near Srinagar (at Burzahom) is found on the edge of the crest of a 110 foot terrace which is made of Karewa lake clays. Nowadays the terrace projects into swampy rice fields; but it is evident that the Neolithic settlers carefully avoided the low ground, which at

that time may easily have been the litoral swamp of an enlarged Dal lake whose present shore line is only some twenty feet below the level of the rice fields. A second Neolithic site at Nuna, in the Sind valley, presents the same picture, the midden lying some seven feet below the surface of a higher terrace which offered safer ground for settlement than the lower valley floor. As the latter is nowadays fully cultivated and settled, it is evident that at some remote time the Neolithic people avoided the valley floor, most probably for reasons of higher stream levels.

Geologically the megalithic sites in Kashmir bear not only traces of a wet period but of a succeeding dry period as well. Both at Burzahom and at Nuna, but especially at the former place, the megalithic settlements lie buried under seven to twelve feet of pottery-bearing yellow or grey silty soil. This soil is unstratified at Burzahom and so porous that it can only be a windblown deposit. Under present climatic conditions dust storms occur in Kashmir, though not as frequently as in the Punjab. A somewhat greater aridity might be required to produce such loess-like deposits. Some of the Karewa and younger terraces in Kashmir are covered by very similar thin loess-loam, and it would seem that these represent the same dry period which succeeded the megalithic culture. The dating of this period depends of course on the archæological analysis of the pottery found. As the oldest pottery underlies the strata with black burnished ware, which is related to the Chalcolithic ceramics of the lower Indus valley, it would seem as if the megalith culture flourished around 3500 to 4000 B.C. This dating should be considered tentative until the pottery has been analysed by the Archæological Survey of India.

In this connection it is, however, interesting that Sir John Marshall (*Mohenjo Daro and the Indus Valley Civilization*, Vol. I, pp. 2–3, London, 1931) and Sir Aurel Stein gave indisputable evidence of heavier rainfall in Baluchistan during the Chalcolithic civilization of *ca.* 3000 B.C. Of the following period Sir John says, "much of the desiccation of Baluchistan must have taken place at some period between the Chalcolithic Period when the population was comparatively dense and settled, and the fourth century B.C., when Alexander the Great made his disastrous march back through the deserts of Gedrosia, and when its condition must have been as parched and barren as it is to-day."

Whatever the causes for this climatic change may have been, it would seem that a wet period persisted in prehistoric times in North-West India which was followed by extensive desiccation. To the latter period, possibly, belongs the post-megalithic soil in Kashmir.

The submerged condition of certain Hindu temples in Kashmir, as at Manasbal and Pandrethan (see Ram Chandra Khak, *Ancient Monuments of Kashmir*, London, 1933) also is indicative of fluctuating water levels in the valley. The foundations of the Manasval temple lie, nowadays, several feet below the level of the neighbouring lake; and Pandrethan also stands below the ground-water level. It is unlikely that the ancient architects selected marsh or litoral swamps for their sites, but dry ground which demanded drier conditions in the valley. The temples date back to the 11th–12th centuries A.D.

Since the early part of the 17th century no very large changes in water levels seem to have occurred in Kashmir, as the shore position of the mooring ghats of some Moghul gardens has been retained.

5. Indirect data from observations on rock engravings, patinations, etc.

Data from certain Tibetan rock engravings were collected by the second author (*l.c.* unpublished) who states that the patination of rock engravings (stupas, ibex, etc.) near Kargil cannot antedate the introduction of Buddhism to the country (8th century). This slight desert varnish must therefore have developed since the early Middle Ages.

At Tang-tse in Eastern Ladak, engravings on patinated granite boulders have been found, from which Hutchinson draws the following inferences :—(1) since early in the present millennium no patination has formed at Tang-tse, (2) the brown desert varnish on the oldest inscriptions antedates the Nestorian engravings, (3) pictures of a species of deer (*Cervus cf. hanglu*) possibly indicates that at some period in the Middle Ages Indian Tibet was damp enough to support richer vegetation than is found there nowadays.

At no place did we observe ochreous patination on recent soils, from which we

conclude that the desert varnish must have formed at a period which possessed a more arid climate than is prevalent in present-day Indian Tibet.

Rock engravings more ancient than either the Kargil or Tang-tse sites, occur below Attock on the Indus and on erratic blocks lying on the higher terraces near Campbellpore (Punjab). Their age is at present still under consideration but in any event they can tentatively be dated as belonging to a period intermediate between the Neolithic and Chalcolithic. These engravings show slight desert varnish which is thinner than the patination found on the native rock. The latter is of no diagnostic value but the patina on the engravings might well belong to a prehistoric dry stage of the post-glacial loess period.

Hutchinson also draws attention to the changes in the altitude limit of agriculture in Ladak (as reported by Francke *op. cit.*, vol. 1). A distinct lowering of this limit has occurred since the time when the "Mons", a pre-Tibetan tribe of the first millennium A.D., cultivated the higher ground. He says, "Although the possibilities of agriculture in this region are limited largely by water-supply and by presence or absence of suitable sites for fields, it is impossible that the present altitudinal limit is set by these factors, seeing that practically the whole of the water-supply of the modern settlements comes from snow and ice on the mountains and local precipitation is probably of negligible importance in agriculture, while level sites are found, notably, near Phobrang, above 4500 m. It is therefore clear that if the limit of agriculture was formerly higher, conditions for ripening the crop, now often cut when partially green, must have once been more favourale. This, like the supposed but unproved extension of the tree line, would seem to point to a drier, warmer period.

In conclusion, the data discussed above may be tabulated as follows :—

POST-GLACIAL CLIMATIC CHANGES IN N.-W. INDIA.

Wet.	5th terminal moraine in Kashmir, Epi-glacial.
—	Assumed dry interval, so far unrecorded.
Wet.	6th terminal moraine in Kashmir, Epi-glacial.
? *Dry.*	Possibly dry pre-Neolithic patination of Indus boulder at Attock and Campbellpore ?
Wet. *ca.* 4000-2500 B.C.	Megalithic settlements in Kashmir. Rainfall in excess of present precipitation in Baluchistan and Upper Sind.
Dry. ? 2000-300 B.C.	Post-megalithic loessic soil in Kashmir. Desiccation in Baluchistan and North-West India antedating Alexander's campaign.
	Pre-Tibetan Mon period, upward extension of agricIture in the first millennium A.D.
? *Wet.* 8th century A.D.	Period of floods in Central Tibet.
Dry. 11th-12th century A.D.	Submerged Hindu temples in Kashmir.
? *Wet.* Middle Ages.	In Western Tibet (Tang-tse) drawing of stag.
Wet. 18th century -early 19th century.	High lake levels on Lake Manasarovar in Tibet. High lake levels in Western Tibet.
Dry. Middle of 19th century.	Low lake levels in Western Tibet.
Wet. Early 20th century.	Almost all lakes rising in Western Tibet.

SUGGESTIONS FOR FURTHER STUDIES.

The above discussion shows how meager our present knowledge on post-glacial climatic changes in N.-W. India is; and we suggest for study, therefore, a number of subjects which, in our opinion, would yield more complete information.

(1) Dendrochronological studies on ancient Deodar trees in the Himalayas and on every kind of wood found in ancient graves. (For instance on pine wood, reported by A. H. Francke from pre-Tibetan Mon graves at Gya in Ladak.)

(2) Studies on lake sedimentation with special reference to the occurrence of brackish or salt water diatoms, such as have already been reported by Lundquist from the Kashmir lakes. Efficient borings through lake sediments would give interesting results as to alternation of $CaCO_3$ and ferrous sulphide rich gyttja deposits.

(3) Additional pollen analysis of Pleistocene and subrecent sediments such as we

began in the last years (see *Memoirs Connecticut Ac. of Sciences*, New Haven, Conn.)

(4) History of village communities in Western Tibet in relation to agriculture, and position of prehistoric sites in relation to drainage pattern.

(5) Analysis of water in closed lakes and estimates of rate of flow into such lakes.

The Karewas of Kashmir.*

By Birbal Sahni, SC.D., F.G.S., F.R.S.,
Professor of Botany, University of Lucknow.

THE well-known fact that the fossil remains of sea animals are found on the crest of the Himalayas frequently conveys to the lay mind a picture of mountain tops submerged in an ocean which rose above those heights. Similarly, lake deposits containing the relics of aquatic plants and animals, if found on the elevated slopes of a mountain, might easily convince the uninitiated that a lake must have once existed at that high level.

That this popular fallacy should have invaded the mind of even a modern scientist is the excuse for the present article.

A few days ago my attention was drawn to a report under the heading "*Prehistoric lake near Gulmarg: abundance of fossil plants*" recently published in the *Civil and Military Gazette* of Lahore.[1] Dr. R. R. Stewart of Rawalpindi, an American missionary and botanist, is reported to have expressed the view that there appears to have been "a lake some thousands of years ago at a height of 11,000 feet, just above Gulmarg".

This opinion is evidently based upon the fact, well known to Indian geologists, that lake deposits containing fossil remains, including modern species of aquatic plants and animals, occur on the slopes of the Pir Panjal Range, at altitudes where these species cannot exist to-day.

This brief article will attempt to explain to the general reader the significance of these high-level deposits, known to geologists as the Karewa Series. The Kashmiri name Karewa is applied to the more or less flat terraces or table-lands which cover a great part of the Valley, specially on the left bank of the Jhelum. In places these terraces are found sloping gradually up the mountains on either side of the valley; excellent examples are to be seen from the road between Srinagar and Gulmarg, on the two sides of the Ferozepur Nala, specially below Tangmarg. Recently they have even been traced up in a continuous series as far as the crest of the Pir Panjal Range, which bounds the Kashmir valley on the south-west.

For the information of those not familiar with Kashmir we may say that Gulmarg is a favourite summer resort at about 8,800 ft. altitude on the densely wooded NE slopes of the Pir Panjal Range. These slopes are thickly covered with the old moraines of glaciers which several times during the Pleistocene Ice Age, overran the greater part of Kashmir. Where the moraines are not covered with forest they form extensive undulating meadows, in the Kashmiri language called *margs*, as at Gulmarg, Khilanmarg, Sonemarg, etc. The Pir Panjal Range runs in a NW-SE direction, roughly parallel to the main Himalayan chain which lies east of it. The celebrated Vale of Kashmir, about 84 miles long and 25 miles in its broadest part, lies protected between these snowclad ranges, at a height of about 5,200 to 5,500 feet above sea-level. The river Jhelum issues from springs near the higher SE end of the valley and meanders peacefully through fertile plains to the NW end which is a few hundred feet lower. Here it escapes in rapids through a gorge near Baramula, only ten miles north of Gulmarg in a direct line. See map, Fig. 1.[2]

Ordinarily a casual newspaper report on a scientific matter does not deserve serious notice. But Dr. Stewart has been commissioned by an important scientific body—the Yale North India Expedition (popularly known here as the Karakoram Expedition)—to identify and describe the fossil plants from some of these lake deposits on the slopes of the Pir Panjal. And the conclusion he has arrived at directly conflicts with one of the main scientific results of the Expedition and, in fact, with long established geological evidence.[3]

The fossil-bearing sediments near Gulmarg, like many other deposits of clay, sand and

* Except for the introductory reference to the press report, this article embodies the substance of an extension lecture delivered at the Punjab University, Lahore, on March 26, 1936.

[1] May 21, 1936, page 5.

[2] This map also illustrates another article in the present volume of *Current Science*, shortly to be published under the title. "*The Himalayan Uplift since the Advent of Man*".

[3] See *e.g.*, Wadia, *Geology of India*, 1926 (Macmillan), pp. 263–264, 383.

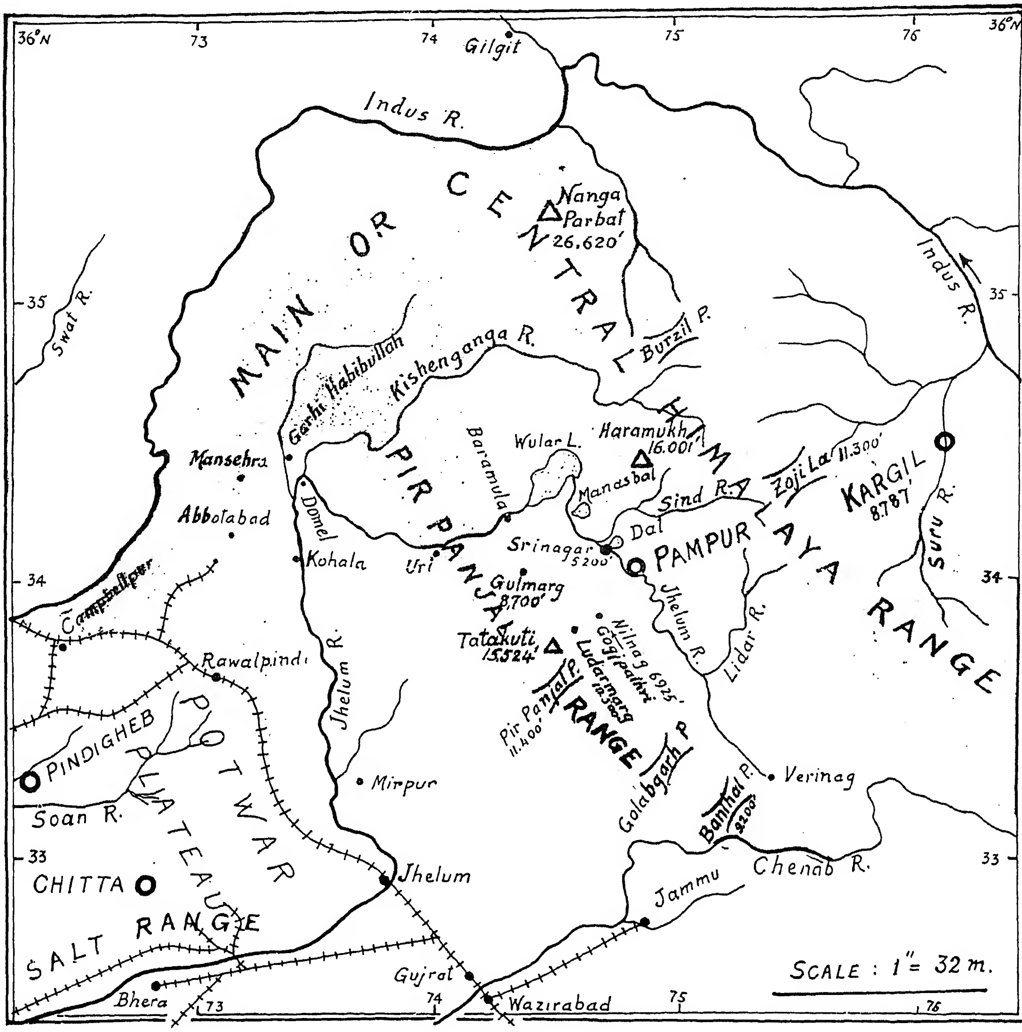

Fig. 1.

gravel on the NE slopes of the Pir Panjal, were no doubt laid down, as Dr. Stewart suggests, in the bed of a lake. *But that lake never existed at the high altitude where its bed is now seen.* Strange though it may seem, this lake must have been situated several thousand feet lower, at the same level as the main valley of Kashmir. Since the time when the plants and animals, of which the fossil remains are now found at 11,000 ft. or even higher, flourished in and around this lake, the sediments have been *lifted out of their original horizontal position* and have been *upheaved through at least five thousand feet with the (geologically speaking) recent upheaval of the Pir Panjal Range.*

The story of these fossil plants from the Pir Panjal Range is briefly as follows. As long ago as 1864, Godwin Austen[4] drew attention to the occurrence of fossil leaves belonging to modern species of plants in clay deposits at Gojipatri (Gogjipatri) near Nilnag, and at Ludarmarg, a meadow about three marches south-east of Gulmarg. Since then fossil plants have been discovered in similar deposits at numerous localities in the Pir Panjal by Middlemiss,[5] Wadia and others.[6] In 1932, Dr. Hellmut de Terra, the

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[4] *Quart. Journ. Geol. Soc.*, XX, 383.

[5] *Rec. Geol. Surv. Ind.*, XLI, 120–121, 125 (1911).

[6] Wadia, *loc. cit.*; Sahni, Presid. Addr. to Bot. Sec., Ind. Sci. Congress, Calcutta, *Proc. As. Soc. Beng.* (*N.S.*), XVII (1921), clxix–clxx; Wodehouse, "The Pleistocene Pollen of Kashmir," *Mem. Conn. Acad.*, IX, Art. I (1935), 3–18, with Introd. Note by H. de Terra, 1–2. Hawkes, Hawkes and de Terra, Yale North India Expedition: Palæolithic Human Industries in N.W.

leader of the Karakoram Expedition, made a large collection which was presented to the University of Lucknow and entrusted for description to the late Dr. S. K. Mukerji. With his extensive knowledge of the modern flora of Kashmir and, especially, his thorough appreciation of the geological aspects of the problem, Dr. Mukerji was exceptionally well fitted for this investigation. But his premature death in 1934 deprived the expedition of a valued collaborator.[7] Subsequently the entire collection, as well as the notes and preliminary identifications left by him, were on Dr. de Terra's request forwarded to Dr. Stewart, who is now continuing the work of my late colleague.

But before his death, Dr. Mukerji had already arrived at some important results, recently announced by Dr. de Terra[8]. Among the numerous types recognised by Mukerji there were not only land plants (chiefly forest trees and shrubs, such as species of oak, willow, poplar, alder, barberry, rose, rhododendron, cinnamon, holly and box), but also several types of aquatic vegetation, notably the waternut or *singhára* (*Trapa*), *Vallisneria* and stoneworts (*Charophyta*). These aquatic plants still flourish in the Dal, Manasbal and Wular lakes, or in the stagnant backwaters of the Jhelum, far away down in the Valley, several thousand feet lower than the heights at which their fossil remains are now found in the Pir Panjal. So far as we know, they do not exist in any of the numerous lakes, tarns and streams on the higher slopes of the mountains, where the water is either too rushy, or frozen for too long a period in the year. The land plants are rather a mixed lot, mostly represented by species now living on the lower slopes, up to about 9,000 feet; a few, like the rose, have a wide range in altitude, while others grow near the upper limit of tree vegetation.

Let us for the moment confine our attention to the aquatic species which, as stated, live only in the lakes and sluggish streams of the valley. How can we explain the presence of their fossil remains at altitudes where we know they cannot exist to-day? Has the climate of these altitudes become colder since these plants lived; or have these species of plants become acclimatised to the warmer waters of the valley? To the layman, at any rate, these would seem to be the only obvious explanations. But, as we shall see presently, both these views are based upon the unwarranted assumption that the lake (or lakes) existed at the altitudes where their deposits are now seen resting, covered with snow for the greater part of the year.

This is the real point at issue. And its importance will be at once realised when I say that it provides the main proof for the view that a great part of the Pir Panjal Range has been uplifted in quite recent geological times: in fact, as we shall see, since the advent of Man in Kashmir.

The idea that the Pir Panjal Range is largely of recent origin is not new. It was suggested long ago by Godwin Austen in unmistakable terms. Twenty-five years ago Middlemiss[9] advanced further evidence in support of it, while Wadia[10] and several other Indian geologists have repeatedly sponsored this view. The Italian explorers Dainelli[11] and de Filippi[12] also arrived at a similar conclusion. And quite recently de Terra and his co-workers have provided further and more convincing evidence in the same direction.[13] As a slight digression we may add that this recent elevation of the Pir Panjal Range is only a small part of a vast upheaval which has affected the main Himalayan range on the one side and the Potwar plateau (between Rawalpindi and Jhelum) on the other, during the period while Man existed in this part of the world.[14] I propose to deal in a later article with the relation of these recent earth movements to the early history of our own species. Here my main concern is to show that the lacustrine beds near Gulmarg, like a dozen other outcrops in which I have collected fossils in the Gulmarg-Baramula region, were deposited in a low-level lake, where the climate was milder.

Punjab and Kashmir, *Mem. Conn. Acad.*, VIII, esp. Introd. and Geological Commentary by de Terra, i–iv, 11–15.

[7] See Obit. Notice in this journal, 1934.

[8] See Wodehouse, *loc. cit.*, Introd. Note by de Terra (1935).

[9] *Loc cit.*

[10] *Loc. cit.* 264, 383.

[11] Studi sul glaciale: Spedizione italiana de Filippi nell' Himalaia, ser. 2, III (1922).

[12] Himalaya, Karakoram and Eastern Turkestan (1932).

[13] See de Terra, Prelim. Report, Yale North India Expedition, *Science*, LXXVII, No. 2004, 497–500 (1933); *Ibid.*, Himalayan and Alpine Orogenies, XVI. International Geolog. Congress, Washington, 1933, p. 9 and literature cited (1934); Hawkes, Hawkes and de Terra, *loc. cit.*; Wodehouse, *loc. cit.*

[14] See Wadia, *Mem. Geol. Surv. Ind.*, LI (2), 334 (1928); *Quart. Journ. Geol. Min. Met. Soc. Ind.*, IV (3), 69–96 (1932) and literature cited.

Similar strata, now tilted at angles as high as 30° to 40°, have long been known to occur in the Pir Panjal, sometimes at altitudes even higher than 13,000 feet above the level of the sea; and it is significant that, except for local variations due to other causes, their slope (geologically known as the "dip") is always towards the Valley. What is more, the same deposits have been traced downwards continuously, with gradually decreasing dip, into the valley, where they are seen mostly in their undisturbed horizontal or almost horizontal position (Fig. 2). At one time the valley of Kashmir must have been covered from end to end by these Karewa deposits, which at least 1,000 feet in thickness, which disclose the chequered history of Kashmir during the ages since primitive man first made his appearance here. Below these "Upper Karewas," which contain abundant plant and animal remains of Pleistocene age, as well as Palæolithic stone implements,[15] there is an even greater thickness of older or "Lower Karewas," dating back into Pliocene times. But with these we are not concerned here.

The nature of a stratum, whether fine clay, sand or gravel; its relation with the underlying or overlying strata; and its fossil contents, if any, indicate whether it was deposited in deep water or near a shore, in

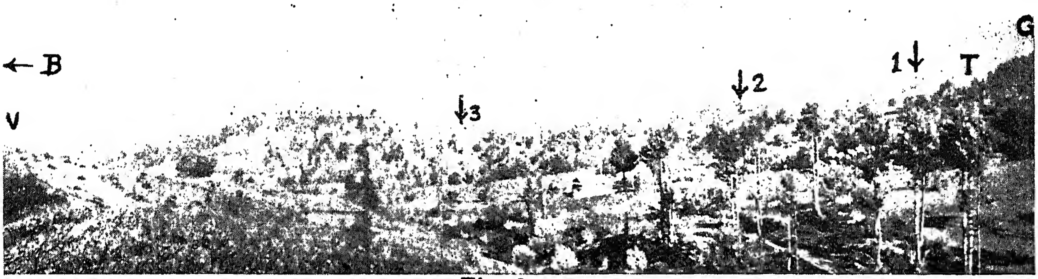

Fig. 2.

View looking east from Naugam ridge towards Dodbug (Surv. of Ind. Map 43 J/8). B points to Baramula; V Karewa deposits in Valley (about 5,500 ft. alt.); T Tangmarg (7,000 ft.); G lies below Gulmarg (8,800 ft.). The white bands 1, 2, 3 are Karewa beds exposed in cliff sections. Note the gradual rise of ground from V to T, about 1,500 ft. in 6 miles. *P(B. S. hoto*, 4-7-1934)

either represent the sediments of a single vast body of water or, perhaps more probably, of a series of connected lakes. The existence of Karewa deposits almost as far as the crest of the Panjal Range shows beyond doubt that this lake must have greatly exceeded the present width of the Kashmir valley; and, although at present there is no such evidence, it is by no means unlikely that in places they may be discovered actually overtopping the range and extending to the south-western (that is, the Punjab) slopes of these mountains.

Rain and rivers have cut up the once continuous expanse of Karewas in the Valley into strips and isolated blocks in the form of flat-topped hills. But these remnants still cover nearly half the area of the Valley, and form a conspicuous feature of the landscape. The Karewa at Pampur, celebrated for its saffron fields, is a picturesque example.

Where the vertical thickness of the Karewa Series of deposits is exposed, for example in ravines and gorges, it reveals an imposing succession of strata, totalling stagnant water or in a stream that fed the lake. Its careful study goes a long way to establish conclusions regarding the climatic conditions and the character of the flora and fauna existing at the time of deposition. We know, for example, that in places the Karewa beds rest upon an ancient rock-bottom which shows unmistakable signs of having once been scratched and polished by glaciers, dragging over the old surface their tremendous weight of ice and its contained rock-débris or "moraine". Elsewhere we find fossiliferous clays, containing evidences of life in a temperate climate, such as the shells or skeletons of modern freshwater animals, or the leaves of familiar forest trees, *interbedded with deposits of undoubted glacial origin, indicating arctic conditions.*

Explorers in Kashmir have found that here, as in Europe during the Ice Age, there were several periods of extreme cold when

15 Hawkes, Hawkes and de Terra, *loc. cit.*, 7, pl. II, fig. 3.

glaciers overran even the lower valleys, alternating with relatively warm periods when the ice retreated to the higher regions and allowed the growth of a temperate flora and fauna. And one of the main tasks of the expedition led by Dr. de Terra was to correlate, if possible, the glacial and interglacial periods of northern India with those of Europe. Important conclusions regarding the way in which the plants and animals in this region responded to the changing physical conditions may also be expected from a detailed investigation of the floras and faunas preserved in the different strata of the Karewa Series.

Under the meadowed moraines of Gulmarg itself, which provide such excellent golf links, fossiliferous interglacial clays are exposed at several places in the banks of the meandering brooks. Some of them are almost black with decayed plant-remains; others, of a blue grey colour, are crowded with the shells of fresh-water mollusca, chiefly gasteropods. They remind one of times when this area lay at a considerably lower level and was covered by a lake teeming with animal life. Then came a cold wave, and glaciers from Toshmaidan and from the heights we now know as the Apharwat descended upon the lake, loaded with débris torn from the rocks in their downward path. With the final melting away of the ice the confused mass of sand, clay and angular boulders of various sizes was left behind in mounds, more or less as we find them to-day (Fig. 3). It will interest the reader to know that of the several kinds of fossil shells which I collected from an interglacial bed near the hotel (Fig. 4) at Gulmarg,[16] at least one species is also found in the recent alluvium of the river Gomti at Lucknow, where the summer temperatures are all but intolerable.

Fig. 3.
Section of re-sorted Moraine at Gulmarg; Apharwat in the background. (*B. S.*)

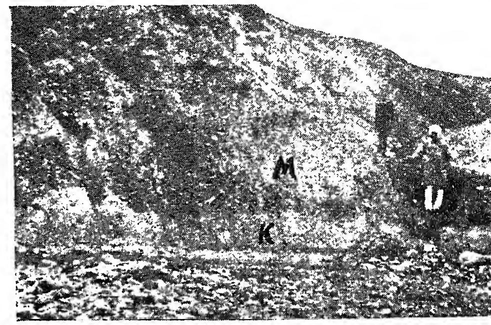

Fig. 4.
Fossiliferous Interglacial Karewa bed (K) underlying a moraine (M). The topmost layer is Loess Gulmarg, 8,750 ft. (*B. S. Photo, July* 1934)

The Ferozepur Nala just above Tangmarg has cut through a large terminal moraine which must have once almost filled the gorge above the village of Māhiyan. Remnants of this moraine must also be present on the right bank of the stream below Drang. The pony track to Gulmarg traverses the moraine at about 7,500 feet above sea-level, where Mr. Wadia has shown me many good examples of ice-worn boulders. Higher up, the moraine is overlain by lake deposits indicating a return to a warmer climate.

Holiday makers in Kashmir might usefully spend some hours in searching for Palæolithic implements in the "Upper Karewas" of the valley. In the Pampur Karewa near Srinagar, Dr. de Terra recently found several pieces of stone, at least one of which was regarded by experts as "*unmistakably....a humanly-worked flake-implement.*" This important discovery, which no doubt will be followed up by further investigation, tends to show, as Godwin Austen had acutely suggested long ago, that the Himalayan uplift had not yet been completed when man first made his appearance on the globe.[17]

Among the most interesting of the Pleistocene deposits of Kashmir are certain extremely thin layers of alternating fine and coarse clay which were deposited in lakes formed by the damming up of valleys by the terminal moraines of glaciers. They are sometimes so thin that they remind one of

[16] I am indebted to my friend Dr. Baini Pershad of Calcutta for kindly identifying these shells for me.

[17] Hawkes, Hawkes and de Terra, *loc. cit.*, pp. 7, 11, 14; pl. II, fig. 3.

the leaves of a book. These so-called "laminated" clays, technically known as "varves", are very characteristic of glaciated countries. The coarser layers are formed of the heavier sediments brought down by glacier streams during the summer when the ice melts more rapidly; the finer layers represent the winters, when the thin streams fail to carry any but the finest paricles. Each varve, with its summer and winter zones, thus usually indicates a period of one year—unless, of course, in a particular year the seasons have been abnormal, as sometimes happens now-a-days. It is thus possible, by counting up the varves in a given thickness of strata, to calculate with a fair degree of accuracy the total period represented by that deposit in solar years. Such calculations have been used with great advantage by geologists in determining the number of years that have passed since a particular area was glaciated. Thus, for example, the Swedish geologist Baron de Geer has been led to suggest that Stockholm became free from the Ice only about ten thousand years ago.

Apart from the seasonal variation shown by the zones within each varve, Swedish workers led by Prof. de Geer have discovered that long climatic cycles during the geologically recent past are recorded in the varying thickness of the annual varves as a whole. During the warm (interglacial) cycles, when the glaciers were in retreat or were confined only to the higher valleys, each varve often reached the thickness of an inch or more. During the glacial intervals they might not be more than a fraction of a millimetre thick. Taking the relative thickness of the varves as a measure of the heat radiated by the sun, Prof. de Geer and his pupils have been able to correlate the glacial and interglacial periods of Sweden with those of North America; and a similar attempt has been made recently by Dr. E. Norin[18] in Northern Kashmir. Only the preliminary results of Dr. Norin's work have so far been published, and it would be rash to accept them at once as final. But if these promising results should prove to be substantiated by fuller evidence they would go a long way to show that in spite of the long distance between the two countries the glacial and interglacial periods in the Himalayas corresponded with those in the Swedish time scale. This they may well be expected to have done all over the world if they were only due to periodic variations in the amount of solar heat received by the earth.

During excursions in July 1934 I discovered near the hamlet of Hajabal, a few miles north of Gulmarg, a narrow ravine in which a great thickness of light and dark brown varves is beautifully exposed in a cliff section. Similar varves, though much folded by subsequent pressure (perhaps due to the advance of a glacier against them) are well seen at Bota Pathri about five miles WNW of Gulmarg. The counting and measuring of these and other varves in the Karewa Series should lead to important conclusions concerning the history of the Ice Age in Kashmir. The organic remains in the associated fossil-bearing strata, as well as fossils collected in several other localities in this neighbourhood, for example, Tsunt Pathri, Nambil Nar, Dandamuh, Satar Siran, to name only a few, are now being investigated by Dr. S. C. Varma of Lucknow.

There is a well-known tradition in Kashmir, which goes back to time immemorial, that the whole of the Valley was formerly occupied by a lake. This is one of those many traditions relating to the physical features of our country which have been found to fit in with the observed facts of Science. The Dal, the Manasbal, the Wular and many other modern lakes in the Valley of Kashmir are but the shrinking remnants of this great Pleistocene lake on whose shores Palæolithic Man plied his stony trade. Writing as I am from the heights of Gulmarg itself, with the Happy Valley mapped out, as it were, before my feet, I can picture this ancient lake, inhabited by a flora and fauna not very different from that which flourishes to-day in the Manasbal or Wular; and surrounded by wooded hills of no great height except towards the north and east, where lay the main range of the Himalayas. To quote Dr. de Terra himself, "This ancient body of fresh water, known as the Karewa Lake, once filled at least 2,000 square miles of the Kashmir valley. On the north it was flanked by the slope of the main Himalaya and on the south by *a low ridge, now represented by the high Pir Panjal Range, which*

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[18] Norin (1925), Preliminary notes on the late Quaternary glaciation of the NW Himalaya. Data 2, Fr. Stockholms Högskolas Geokronol. Inst., *Geografiska Annaler*, H. 3; Norin (1927), Late glacial clay varves in Himalaya connected with the Swedish time scale. Data 11, *Ibid.*, H. 3.

separated the lake basin from the Indian plains."[19]

The prehistoric lake of which Dr. Stewart speaks may well have been part of the Karewa Lake, and the plants and animals now found as fossils at high altitudes lived in that lake or on the wooded slopes bounding its western shores. The leaves and twigs, fruits and seeds of the forest trees were carried down by streams and became mixed up with the remains of the low level aquatic vegetation buried in the silt of the lake. Apart from these larger fragments of plants, which can be recognised by the unaided eye, the pollen of many species of trees and herbs was also carried down by the water, or was blown down and became sealed up in the clay. Owing to the fact that, like the cuticles of plants, the outer coat of these microscopic pollen grains is very resistant to the natural agents of decay, and because the pollen of many plants is very characteristic, it has been possible for Dr. Wodehouse to recognise several kinds of plants from their pollen grains alone, both in the Karewa deposits and in the silt that is being laid down to-day in the beds of the modern lakes of Kashmir.

Before closing this brief account of the Karewas mention must be made of a wide-spread deposit of fine yellow or brown sandy earth, known as Loess. In places it forms a mantle several feet thick over the Karewas: it is distinguished by a tendency to form steep slopes or cliffs which are marked by rather charcteristic sinuous rills. The Loess is a deposit of modern times, regarded in origin as wind-borne dust blown over from the plains. Good exposures are to be seen on the golf links at Gulmarg. The Loess has its own importance in the study of human history, but the subject is beyond our present scope.

This is, briefly, the romantic story of the Karewas of Kashmir. Their study leads to the irresistible, though at first incredible, conclusion that the Himalayas have been thrown up by several thousand feet since the advent of man. We may well repeat, in the words of our inspiring teacher of geology, the late Professor T. McKenny Hughes: "Don't be afraid of earth movements, don't be afraid of earth movements"!

GULMARG (Kashmir),
June 13, 1936.

[19] Introd. Note to Wodehouse (1935), *loc. cit.*, p. 1. The italics are mine. See also De Terra (1936), Late Cenozoic history in India, *Nature*, 137, 686–688.

"Indian Science Abstracts".

THE National Institute of Sciences of India, Calcutta, resolved to issue a publication under the title '*Indian Science Abstracts*' with the sub-title '*Being an Annotated Bibliography of Science in India*' every year. The first part of this publication has just been issued, but the General Editor, realising the impossibility of making such a publication complete without the active co-operation of all scientific workers in the country, requests them kindly to look through the ~~1st Part~~ and see whether all their scientific publications issued during 1935 have been included in it. A great deal of matter for the 2nd Part is already in type, and if all the workers will kindly help by sending abstracts of such of their papers as have not been included in Part I, this will ensure making the record complete for all the scientific publications issued during 1935. *En passant* it may be noted that the publication is intended to include abstracts of all scientific papers published in India, as also of papers published abroad on work done in India or based on Indian material.

The arrangement of abstracts in Part I of the "*Abstracts*" is purely tentative, and any suggestions for making the publication more useful will be gratefully received, and an attempt made to embody, as far as possible, such suggestions in the succeeding parts.

Instructions for the prepartion of abstracts can be obtained from the offices of the National Institute of Sciences of India, 1, Park Street, Calcutta.

Obituary.

WE have to record our profound sense of sorrow at the premature death of Principal Dr. Krishna Kumar Mathur, Principal of the Science College, Benares Hindu University, on July 18th at Lucknow. Dr. K. K. Mathur was one of the foremost geologists of India, who had won the esteem and affection of all his fellow-workers, and had served the Benares Hindu University in various capacities with faithful devotion.

LETTERS TO THE EDITOR.

CONTENTS.

On the Geiger-Nuttal Relation.

It is well known that the velocity of the particles emitted by radioactive substances is determined from an experimental measurement of the range and the empirical relation of Geiger-Nuttal, connecting the range with the velocity. An attempt to deduce a similar formula on theoretical grounds, was made by Bohr as early as 1913. Recently, Gaunt[1] and Bethe[2] have deduced the corresponding wavemechanical formulæ. In these theories the classical dynamics is freely used at a later stage, to arrive at a formula somewhat analogous to that of Bohr. Moreover, Bethe's formula involves a function which is computed with difficulty.[3]

According to the wavestatistical theory, which is just developed and is being published elsewhere, the general relation connecting the range (R) with the velocity (v) is of the form

$$R = \ldots + a_2 v^2 + a_3 v^3 + a_4 v^4 + a_5 v^5 + \ldots$$

where a_2, a_3, . ., etc., are constant coefficients. It may be remarked that v^3- and v^4-terms are found to be important, the other terms coming only as approximations. Thus Geiger's v^3- and v^4-rule for low and high velocity, is supported by the wavestatistical theory.

K. C. Kar.

Presidency College,
Calcutta,
June, 1936.

[1] *Proc. Camb. Phil. Soc.*, 1925–27, **23**, 732.
[2] *Ann. der Phys.*, 1930, **5**, 325.
[3] *Vide* Blackett, *Proc. Roy. Soc.*, 1932, **135**, 132.

Constitution of Formic Acid and the Formates.

In a letter to the Editor Mr. Halasyam[1] suggests that the values used by me for the calculation of the parachor of formic acid[2] were an arbitrary selection of the values of Sugden and of Mumford and Phillips. Actually as indicated[3] in foot-note 4 the calculated value (93·2 units) which I gave is the standard value given in Landolt-Bornstein,[4] the atomic and structural constants used in that calculation being those which are generally regarded as the best. The differentiation between hydrogen attached to oxygen and hydrogen attached to carbon adopted in Landolt-Bornstein is an improvement on the original values of Sugden, which is justified in that it enables satisfactory values of the parachor to be calculated not only for formic acid, but also for a wide range of hydroxy-compounds.[5]

Mr. Halasyam in his original calculation of the parachor of the Sarkar-Ray formula for formic acid[6] used Mumford and Phillips' values. In his recent letter[7] he quotes for the classical formula the value of 102·2 using Sugden's unrevised values which are now out of date, and which also give incorrect values for other acids, for which there is no question of an alternative formula. As indicated in my previous letter, the best modern calculated value for the parachor of the classical formula agrees closely with the experimental value. Mr. Halasyam has nowhere quoted for comparison a Mumford-Phillips value for the

parachor of the classical formula. These authors[8] calculate on their system the parachor of acetic acid to be 130·6. Deducting their value for CH_2 (40·0), the value for the classical formula for formic acid comes out to be 90·6 which is sufficiently close to the observed value of 93·6.

It is clear therefore, and in this Dr. Seshadri agrees with me[9] that parachor values cannot be used to distinguish between the Sarkar-Ray and the classical formula for formic acid.

With regard to the abnormal chemical activity of formic acid, Mr. Heble, in this laboratory, has recently observed that formic acid reacts with acetyl and benzoyl chlorides to give the corresponding acid, HCl and CO. It also reacts on heating with benzyl chloride, benzal chloride, and benzotrichloride with evolution of HCl and CO; on these reactions a method of estimating side-chain halogen has been based.

T. S. Wheeler.

Royal Institute of Science,
Bombay,
June 15, 1936.

1 *Curr. Sci.*, 1936, **4**, 812.
2 *Curr. Sci.*, 1936, **4**, 650.
3 *Loc. cit.*
4 *2nd Supplement*, 5th Edition, 1931, pp. 172, 173, 175, 177.
5 *Cf.* Bhatnagar and Singh, *J. Chim. Phys.*, 1928, **25**, 21.
6 *J. Indian Chem. Soc.*, 1935, **12**, 813.
7 *Loc. cit.*
8 *J.C.S.*, 1929, 2128.
9 *Curr. Sci.*, 1936, **4**, 813.

Decolourising Action of Fuller's Earth.

The decolourising action of fuller's earth and its activation by acids have not yet been satisfactorily explained on chemical or physical basis. Earlier attempts deal with either the chemical constituents of the earth,[1,2] or with the usual absorption theories.[3] Recently Thurman[4] attempted to show the relationship between the pH of the earths and their decolourising action. But according to him, addition of acid or alkali decreased the decolourising power of a Florida earth. Fogle and Ohn[5] attributed the clarifying action of the fuller's earth to its zeolite content, but account has not been taken by these authors of an important characteristic property of these earths, of liberating acid on being shaken with a salt solution.[6] In the course of our work on the activation of fuller's earths obtained from different parts of India, for decolourising vegetable oils, we found that the pH of a solution of sodium chloride after treatment with earths varied in the same manner as the change in the Lovibond units of colour of a sample of groundnut oil treated with the earths. The bleaching values were determined by agitating a sample of neutral groundnut oil with 2 per cent. of the earth at 90°–95° C. and matching the colour with a Lovibond tintometer. For activation, the earths were treated with hydrochloric acid of 19–20 Be′ (added as 20 grams of dry HCl per 100 grams of the earth) under reflux for three hours, and washed.[7] For

Table I.

No.	Source	Original		Treated with acid and washed			
				Heated to 110° C.		Heated to 400° C.	
		Change Lovibond Units	pH	Change Lovibond Units	pH	Change Lovibond Units	pH
		y		y		y	
1	Florida	3·3	3·74	3·1	3·24	3·1	4·02
2	Kolhapur	1·4	7·22	2·9	3·76	2·0	4·95
3	Jodhpur	2·4	7·82	2·9	3·47	3·2	3·91
4	Bhawanagar	1·1	8·81	3·0	4·10	3·2	4·70
5	Murwara, C.P.	1·4	7·48	1·3	4·71	2·1	6·36
6	Germany	3·2	3·50	3·3	3·45	3·3	3·60

pH measurements 50 c.c. of one per cent. solution of sodium chloride was shaken with 0·5 gram of the earths. The table given above gives some of the results which are graphically shown in Fig. 1.

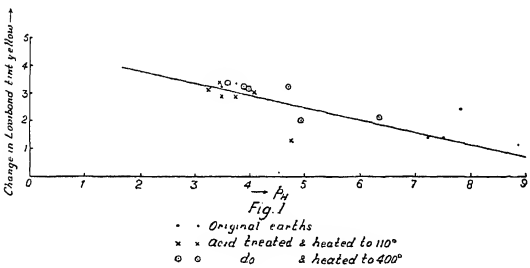

Fig. 1.

The accuracy of the colour measurements as compared with the accuracy of the pH measurements by the quinhydrone electrode is limited by the use of the Lovibond Tintometer and accounts for the discrepancies. Our results, however, indiciate that the decolourising action and the activation by acids of these earths are directly related with the exchangeable hydrogen contained in the earth. While thus indirectly supporting the conclusion of Fogle and Ohn regarding the zeolitic nature of the active ingredient in the fuller's earth, our results show that it is not "calcium" zeolite but "hydrogen" zeolite that is active in decolourising. It is possible that the action of the zeolite is replaced by the hydrogen ion during the process of activation by acids, the hydrogen in turn being replaced by the sodium ion when treated with the salt solution, both reactions being governed by the law of mass action. The "hydrolytic adsorption," by other clays can be explained on the same basis. Further work is in progress.

B. S. KULKARNI.
S. K. K. JATKAR.

Department of General Chemistry,
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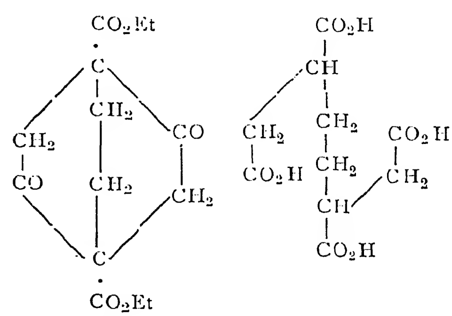
Bangalore,
June 29, 1936.

[1] Welds, *Z. Angew. Chem.*, 1927, **40**, 7982.
[2] Haseman, *J. Phys. Chem.*, 1929, **33**, 1514.
[3] Neuman, *Z. Angew. Chem.*, 1927, **40**, 337.
[4] Thurman, *Ind. Eng. Chem.*, 1932, **24**, 1189.
[5] Fogle and Ohn, *Ind. Eng. Chem.*, 1933, **25**, 1070.
[6] Bancroft, *Applied Colloid Chemistry*, 3rd Ed., p. 146, McGraw-Hill, 1932.
Also *Cf.* Chameron, *J. Phys. Chem.*, 1910, **14**, 400.
[7] Burgharat, *Ind. Eng. Chem.*, 1931, **23**, 801.

p-Bridging of Succinosuccinic Ester.

CONSIDERING the products obtainable from succinosuccinic ester by bridging the *p*-carbon atoms with methylene iodide or ethylene bromide "to be of extremely great interest," Baeyer[1] tried the experiments evidently without success. The non-formation of a strainless tricyclic system from bi*cyclo*-nonanedionetetracarboxylic ester, alike Baeyer's failure, were attributed by Meerwein[2] to the splitting up of the bridged compounds by alkali.

After a large number of attempts made under varying experimental conditions, the desired bridge formation has now been effected by boiling dry sodio-derivative of succinosuccinic ester under reflux during 72 hours with ethylene and trimethylene bromides, the resulting compounds melting at 112° and 132° respectively. That the reactions have not taken place in the enolic phase, is proved by the fact that the bridged compounds give sharp melting disemicarbazones. The bridged esters are easily hydrolysed to the corresponding diacids, m.p. 274° and 238° respectively by boiling with dilute HCl (1 : 1) and these acids, in turn, give sharp melting disemicarbazones. It is interesting to note that the bridged esters cannot be decarboxylated under conditions in which succinosuccinic ester readily gives 1 : 4-diketohexamethylene. The compound, m.p. 112° (I) on treatment with 10 per cent. alcoholic potash suffers ring fission to yield, what appears from combustion analysis and equivalent determination to be $\beta\beta'$-dicarboxysuberic acid, m.p. 170° (II) as yet unknown and on treatment with 1·5 per cent.



(I) (II)

neutral permanganate it gives an acid, m.p. 150° which, however, seems to be

different from adipic acid. Further work is being continued. P. C. GUHA.

Department of Organic Chemistry,
Indian Institute of Science,
Bangalore, India,
April 25, 1936.

[1] Baeyer, *Ber.*, 1892, **25**, 2123.
[2] Meerwein, *J. Pr. Chem.*, 1922, (ii), **104**, 180.

A Synthesis of *Cis*- and *Trans-dl*-1-*iso*-Propyl *Cyclo*propane-1 : 2-Dicarboxylic Acids and a Resolution of the *Cis* Acid. Synthesis of Umbellularic Acid.

IN his experiments on the constitution of umbellulone, Tutin[1] obtained as the ultimate product of its oxidation, an optically active dibasic acid, umbellularic acid, $C_8H_{12}O_4$, m.p. 120–121° $(\alpha)_D - 89 \cdot 7°$ (in $CHCl_3$). Although Tutin believed the acid to be a derivative of methyl *cyclo*-pentane, the experiments of Semmler[2] definitely fixed its constitution as 1-*iso*propyl *cyclo*propane-1 : 2-dicarboxylic acid. The *cis*- and *trans-dl*-forms of this acid have now been synthesised.* Also the *cis* acid has been resolved into its optical antipodes and the properties of the latter are identical with those of umbellularic acid.[1]

Ethyl α-*iso*propyl acrylate[3] adds on ethyl diazoacetate to give ethyl 5-*iso*propyl-Δ' pyrazoline-3 : 5-dicarboxylate, b.p. 158° at 1 mm. and the latter splits off nitrogen at 200°[4] giving rise to the mixed ester, b.p. 144-48°/28 mm. On hydrolysis this furnishes *trans-dl*-1-*iso*propyl *cyclo*propane-1 : 2-dicarboxylic acid (m.p. 195°·0 C.)† in about 35% yield, the rest being a liquid mixture of unsaturated acids. The *cis* anhydride prepared from *trans* acid by heating with acetylchloride at 180°, boils at about 140°/20 mm. The *cis-dl*-acid crystallises from water with one molecule of the solvent (m.p. 95°, sintering 86°). The anhydrous acid melts at 124–125° and passes over to the anhydride at 150°. The chemical properties of these two acids are identical with those of umbellularic acid.[1]

On combining *cis-dl*-acid with brucine in aqueous solution the salt of the *d*-form separated first, and had the composition $C_{54}H_{64}O_{12}N_4 \cdot 9H_2O$ $(\alpha)_D^{30°} - 25 \cdot 63$ (in alcohol). The active acid liberated from the salt had $(\alpha)_D^{31°} + 87 \cdot 7$ (in $CHCl_3$), m.p. 118° with $1H_2O$ about 83°. For obtaining the *l*-acid cinchonidine was employed, when the salt of the *l* form $C_{27}H_{34}N_2O_5$, separated first. The acid liberated had $(\alpha)_D^{31°} - 81° \cdot 13$. The crystalline forms of both the antipodes were in agreement with those cited by Tutin for umbellularic acid.

Full details of the work have been sent for publication elsewhere.

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June 11, 1936.

[1] Tutin, *J.C.S.*, 1906, **89**, 1104.
[2] Semmler, *Ber.*, 1907, **40**, 5019 ; *Ibid.*, 1908, **41**, 3988.
[3] Blaise and Luttringer, *Bull. Soc. Chim.*, 1905, (3), **33**, 648, 776.
[4] Buchner and Papendieck, *Annalen*, 1893, **273**, 232. von Auwers and König, *Ibid.*, 1932, **496**, 252.
* The Synthesis of the *dl*-acids was complete and the resolution of the *cis* acid was in hand when an abstract on the synthesis of umbellularic acid appeared (Rydon, *Chem. and Ind.*, 1936, **55**, 294). The method adopted by Rydon, however, is different and we thought it fit to continue our work and place the results for publication.
† The figures for melting point given in this note are all uncorrected.

Apparatus for the Measurement of Respiratory Exchange in Plants.

FOR the measurement of respiratory gaseous exchange in plants Haldane's gas-analysis apparatus is commonly employed. Although highly accurate, the apparatus in its original form[1] is inconvenient and rather cumbersome for respiration studies in plants. Carpenter[2] has replaced the long, cylindrical levelling tube which is rather difficult to manipulate, by a small mercury bulb which is easily handled. The original Haldane apparatus contains a combustion pipette for the oxidation of carbon monoxide or methane. This pipette was utilised to advantage by Carpenter[2] for the absorption of oxygen by means of moist phosphorus. It has the advantage over potassium pyrogallate that it does not have to be renewed so frequently and that the absorption can be carried out without the continuous raising and lowering of the mercury levelling bulb. In this Laboratory, however, during the course of investigations on the gas-storage of tropical fruits the apparatus has been further simplified and the technique for the measurement of respiratory exchange in plants considerably improved. The gas sampler employed by Haldane has been dispensed with, the measuring pipette serving as a sampling appliance as well. The potassium pyrogallate bulb (together with its accessory bulbs) has been replaced by a phosphorus bulb of the type employed by Carpenter,[2]

thus minimising the breakages which frequently occur in this apparatus. For the simultaneous determination of the CO_2 evolved and the oxygen absorbed, the plant organs are enclosed in air-tight chambers which provide for the removal of test portions for analysis. The use of respiration chambers with rubber stoppers is open to criticism, as rubber has a tendency to absorb CO_2 and also to let it diffuse through it. To circumvent this difficulty, two new types of respiration chambers have been constructed into which the various gas mixtures are easily introduced and which are trustworthy in regard to their air-tightness. A method, similar in principle to the Münzer-Neumann method[3] for the calibration of Warburg and Barcroft manometers, is suggested for the calibration of the respiration chambers after the introduction of the plant material.

The measuring pipette P of the apparatus (Fig. 1) can be put in communication either with the KOH bulb C or the phosphorus bulb D by means of the Friedrich-Greiner tap F. The phosphorus bulb is similar in construction to the combustion pipette employed by Haldane except that the ignition tubes inside it have been removed and a water levelling bulb added. The bulb is filled with stick yellow phosphorus of suitable length so that 21 c.c. of gas can be introduced into it. The measuring pipette P and the compensation pipette P′ are enclosed within a glass jacket, the water in which is kept stirred by means of an air-blower B. The manipulation, in brief, is as follows. The air in the apparatus is first freed from CO_2 and oxygen in order that all of the capillaries may be filled with nitrogen. Subsequent to this, the 3-way stopcocks G and H and the tap F are turned

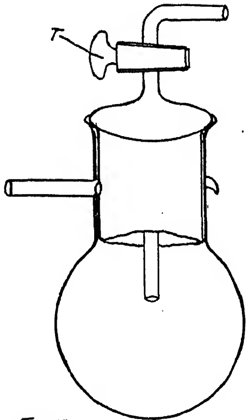

FIG. 3.

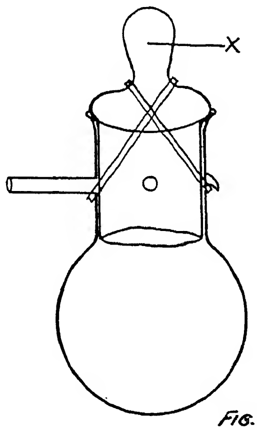

FIG. 2.

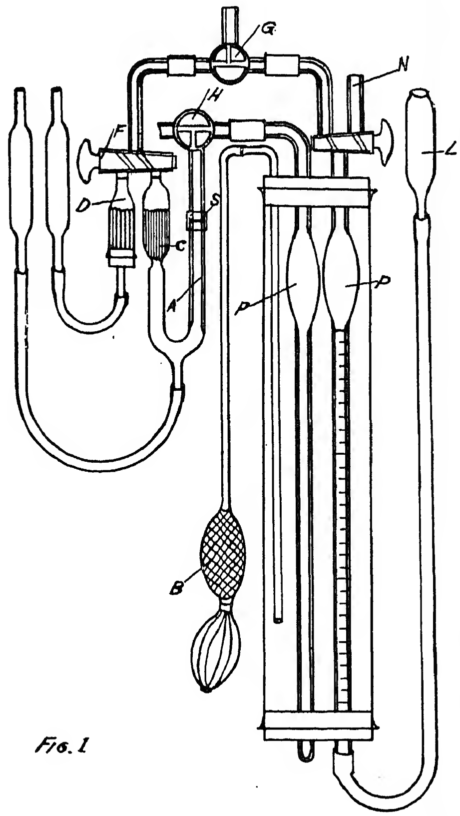

FIG. 1

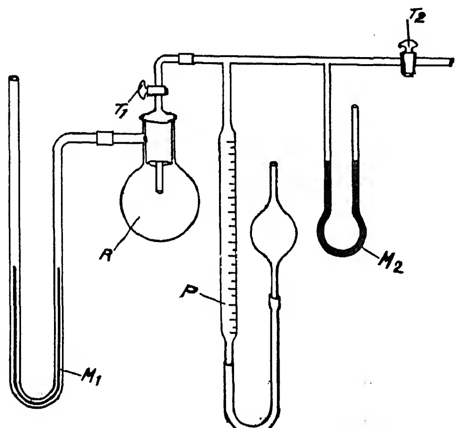

FIG. 4.

An Adaptation of Haldane's Apparatus for the Measurement of Plant Respiration.

in the positions shown in Fig. 1, and the KOH levels on the potash bulb C and the side tube A are set. The sliding mark S on the tube A can be moved up or down as the case may be. After this the taps G and H are turned so that the apparatus no longer communicates with the atmosphere at these points. Sampling is done (by the washing method) by interposing a 3-way stopcock between the tube N and the respiration chamber, the gas samples being drawn in and sent out of the measuring pipette by means of the levelling bulb L. As a rule, 2–3 washings give satisfactory results invariably. Further details of procedure have already been described by Carpenter.[2]

When it is required to measure only the respiratory quotient (*e.g.*, in following the chemistry of respiration) the respiration chamber (capacity 500–600 c.c.) depicted in Fig. 2 is employed. In carrying out an experiment, a single fruit is put into the respiration chamber and the required gas mixture introduced by the evacuation method.[4] The chamber is subsequently closed by turning the ground-glass stopper X, which is kept in position by two strong rubber bands stretched across it (Fig. 2). The respiration chamber shown in Fig. 3 is used when it is intended to know the absolute amounts of CO_2 evolved and oxygen absorbed in addition to the respiratory quotient. For this purpose it is necessary to determine the total volume of the gas mixture as well as the percentages of its different constituents.[5] The gas analysis yields the percentage content of the various components whereas the volume of the gas space in the respiration chamber is determined by employing the Münzer-Neumann method.[3] The arrangement is represented diagrammatically in Fig. 4. The respiration chamber is represented at R, P is a graduated 5 c.c. pipette, and M_1 and M_2 are two manometers containing paraffin. After levelling the manometer M_2 and closing the tap T_2, the mercury in P is lowered so as to withdraw some gas from the respiration chamber. After this the tap T_1 is closed, and the manometer M_2 is adjusted exactly to level once more. The difference in the readings of the manometer M_1 gives the decrease in pressure in the respiration chamber and that in the readings of the pipette P gives the volume of gas withdrawn at the atmospheric pressure. Applying the Boyle-Mariotte law, the desired total volume of gas in the respiration chamber is easily computed.[5]

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India,
May 20, 1936.

[1] Haldane, *Methods of Air Analysis* (London), 1912.
[2] Carpenter, *Carnegie Inst. Wash.*, *Pub.* No. 216, 1915, p. 70.
[3] Münzer and Neumann, *Biochem. Z.*, 1917, **81**, 319.
[4] Keilin, *Proc. Roy. Soc.*, *Lond.*, 1929, **104B**, 206.
[5] Kostychev's *Plant Respiration* (Eng. trans. by Lyon), 1927, Philadelphia.

Observations on the Dark, Opaque Inclusions in the Nellore Garnets.

THE garnet which encloses the inclusion being almost transparent in thin sections, these inclusions which are black and opaque, are clearly visible in transmitted light. Micrometric estimates show that they form about two per cent. of the garnet by volume. They have submetallic to adamantine lustre; streak is black; colour iron-black with a slight violet tint. Most of these inclusions are granular but some of them are minute tabular crystals, often in thin plates or laminæ. These inclusions are magnetic and they are magnetically more powerful than almandite (garnet) but slightly less than ilmenite. Under the microscope in transmitted light, these inclusions are opaque except for a few enclosed rutile crystals. In reflected light they exhibit a steel-grey colour tinged with pale violet. While some of them show clear crystal boundaries when examined "*in situ*," many present a streaky and granular appearance.

To separate these inclusions from the garnet the following procedure was adopted: A few crystals of garnet were reduced to a 100 mesh powder which was then treated with an electromagnet when a concentrate of this black mineral was obtained. The impurities and lighter minerals like quartz which accompanied the concentrate were removed by using a heavy liquid (methylene iodide). A pure sample was then obtained by repeatedly treating the concentrates with a horse-shoe magnet to the poles of which two needles were attached to bring about a pointed field. A final picking under a microscope was also resorted to.

When strongly heated, these inclusions change to a brownish black colour and an increase in weight is also noticed. When

fused with Na_2CO_3 the material is only slowly decomposed, but fusion with either potassium bisulphate or sodium bisulphate results in complete decomposition of the material and the fused mass thus obtained dissolves readily and almost completely in hot dilute H_2SO_4. These inclusions give no tests for either calcium or manganese, but no attempt was made to test for the presence of alkalies. A very pure sample of these inclusions obtained as indicated above was analysed and the results obtained are as follows:

ANALYSIS OF INCLUSIONS.

Oxides.	Per cent.
TiO_2	65·85
FeO (by difference)	18·84
Fe_2O_3	15·31
SiO_2	trace
Total ..	100·00

A complete analysis of the entire garnet showed a titanium content of nearly 1·0 per cent. Since careful tests with clear garnet grains as well as with the quartz inclusions found therein, showed complete absence of titanium, it appears certain that all the titanium associated with the garnet is present in these black inclusions.

A microscopic study indicated that crystals of rutile are sometimes present in the inclusions to the extent of 7 to 8 per cent. This small quantity of rutile cannot account for the high percentage of TiO_2 found by chemical analysis. The chemical analysis shows also that the TiO_2 content is far in excess of the ferrous oxide required to form normal ilmenite, and that there is in addition a large proportion of ferric oxide. Further work is in progress with a view to explain the large TiO_2 content of these inclusions.

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June 11, 1936.

A Preliminary Note on the Development of Embryo-sac in *Averrhoa carambola* Linn.

THE earlier work on the development of the embryo-sac in Oxalidaceæ is limited to a few species of *Oxalis* worked out by Hofmeister (1858), Johnson (1881), Billings (1901), Hammond (1908) and Schürhoff (1926) as cited by the latter author[1] in his book, besides work on other phases of its embryology. Hence it has been thought worthwhile to examine first an arborescent representative, *Averrhoa carambola*. The writer, however, hopes to complete the work on other Indian representatives of the family and the material has already been accumulated.

During the early stages of the ovule, the nucellar cells at its tip stain like archesporial cells, although only one of them grows further to form the megaspore mother-cell. The single archesporial cell undergoes a periclinal division and cuts off a parietal cell. The latter again divides further to form a not extensive parietal tissue above the embryo-sac. The megaspore mother cell undergoes the usual heterotypic and the homotypic divisions resulting usually in a linear tetrad and occasionally in a T-shaped one. Both the types of tetrads have, however, been seen in the same ovary. The chalazal megaspore is the functional one and develops in the normal manner into an 8-nucleate embryo-sac, after three successive free nuclear divisions. In the young embryo-sac the antipodal cells are organised first. They degenerate early before fertilisation. The synergids then differentiate out and become hooked. The polar nuclei start from their respective poles, meet about the middle of the embryo-sac, move upwards and take their position near the egg apparatus. The embryo-sac undergoes an increase in size on all sides. It crushes the parietal tissue above and the nucellus on the sides and ultimately becomes situated just below the nucellar epidermis except at its chalazal part. Thus the embryo-sac follows a normal course of development and becomes 4-nucleate just before fertilisation due to the early degeneration of the antipodals. These observations accord with those of the earlier investigations.

Full details of the embryology of this species will be published elsewhere in due course.

In the end the writer takes great pleasure in expressing his sincere thanks to Mr. I. Banerji for valuable guidance during the progress of the work and also wishes to express his deep indebtedness to Prof. S. P. Agharker, M.A., Ph.D., for affording facilities in the Botanical Laboratory, University College of Science, Calcutta, where the investigation has been carried out.

Cocanada, V. VENKATESWARLU.
June 4, 1936.

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[1] Schurhoff, P. N., *Die Zytologie der bluten-pflanzen*, Stuttgart, 1926.

On the Existence of Two Different Types of Striped Eyes among Solitary Type Specimens of the Desert Locust *Schistocerca gregaria* Forsk.

IT was discovered in 1932 at the Locust Research Laboratory, Lyallpur, that there is a striking difference in the colouration of the compound eyes of the adults and hoppers of the two phases, *solitaria* and *gregaria*, of the Desert Locust. While in the *phasis gregaria* the eyes are uniformly claret coloured, those of the *solitaria* show a number of chocolate-coloured stripes alternating with cream-coloured interstripes.

The writer has worked out the histological basis of this difference and its probable physiological significance in the vision of the locust. Briefly, the findings were that whereas in the unstriped or "gregarious" eye, both the primary (distal) and secondary (proximal) pigment cells of an ommatidium are pigmented, in the striped or "solitary" eye such a condition obtains only in the ommatidia lying beneath the stripes. In the ommatidia lying beneath the interstripes the secondary pigment cells alone are pigmented. Other smaller differences also occur.*

An examination of a large number of specimens of the Desert Locust found in the breeding ground of Mekran (Baluchistan) and showing the solitary colouration, has shown that, while in the majority of cases the compound eyes have six stripes (and seven interstripes), in others seven clear stripes (and eight interstripes) are present. Thus any considerable collection of solitary locusts can be divided into two types, *viz.*,

Type I—with 6-striped eyes (Fig. 1).
Type II—with 7-striped eyes (Fig. 2).

In both the types, the second interstripe (IS^2) from the posterior side, is always broader than the rest and forms, so to speak, a landmark in the eye. It is found that whereas there is always a single stripe behind this interstripe, the number of stripes anterior to it may either be five or six, thus giving rise to the two types of eyes mentioned above.

An analysis of 727 locusts have shown (Table I) that the type with the 6-striped eyes is more common, forming 79·3% of the locusts examined. Since the number of stripes in the large number of specimens examined was invariably either six or seven the two types cannot be regarded as a case of simple variation. The origin of this difference is, however, obscure. Whether the difference is inherited in a genetic way, can be shown only by extensive breeding experiments.

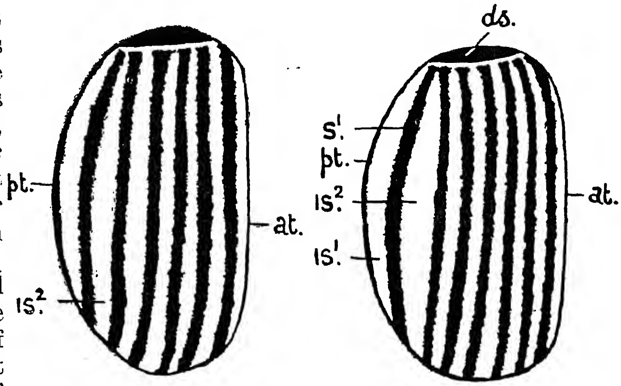

Fig. 1. Fig. 2.

Fig. 1.—Side-view of the left eye of a female of *Schistocerca gregaria*, phase *solitaria*, showing 6 eye-stripes. × about 10. *at.*, anterior margin of eye; IS^2, second interstripe from the posterior side; *pt.*, posterior margin of eye.

Fig. 2.—Side-view of the left eye of a female of *Schistocerca gregaria*, phase *solitaria*, showing 7 eye-stripes. × about 10. *at.*, anterior margin of eye; *ds.*, dorsal spot of eye; IS^1, first interstripe from the posterior side; IS^2, second interstripe from the posterior side; *pt.*, posterior margin of eye; S^1, first stripe from the posterior side.

TABLE I.

Types of striped eyes	Sex	No. of specimens	Total No. in each type	Percentage in each type
Type I—with 6 stripes	♂	348	578	79·3
	♀	230		
Type II—with 7 stripes	♂	62	149	21·7
	♀	87		

It is proposed to make further observations in the course of the year as to the significance of this difference.

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Locust Research Field Laboratory,
Pasni, Baluchistan,
June 6, 1936.

* This investigation, as yet unpublished, was carried out during 1932–33 at the Locust Research Laboratory, Lyallpur, under the general direction of Mr. M. Afzal Hussain.

SUPPLEMENT TO "CURRENT SCIENCE".

Vol. V] July 1936 [No. 1

The First Jena Catalogue of Optical Glasses Published in 1886.

By

Prof. Dr. Moritz von Rohr

THE chromatic aberrations met with in modern optical instruments and their correction are best and most fruitfully discussed by looking back to the work of the early pioneers.

We may mention that Newton's genius began investigating the coloured band of the primary spectrum, and his subdivision of it into the 7 parts (the *partial dispersions* in our language) of red, orange, yellow, green, blue, indigo and violet was accepted for more than 100 years.

Whereas Newton thought it impossible to devise refracting instruments free from colour aberration, it was in the years between 1729 and 1733, that a gifted amateur, Chester Moor Hall, actually planned an achromatic object glass (composed of a positive crown and a negative flint lens) for a telescope and had it successfully made by London opticians. But the time was not yet ripe for his great invention and the optical world had still to wait a quarter of a century till 1758, when J. Dollond brought on the market his famous achromatic telescopes.

They were certainly generally appreciated, but in 1762 A.C. Clairaut, a French scientist, was able to show that in Dollond's achromatic glasses not every trace of colour had been destroyed and that the reason for this was to be found in the fact that the partial dispersions from red to violet were *not proportionate* in the crown and in the flint glass.

No numerical valuation of this want of proportionality could be given at that time, as the boundary lines between the 7 coloured parts were much too indistinct. Every improvement in the colour correction during the latter half of the 18th century was therefore restricted to trial and error.

In this latter half of the 18th century two scientists must be mentioned in this respect: Father R. J. Boscovich S.J., a professor at the Paduan University, who published his very important views on this subject about the year 1765, and R. Blair

of Edinburgh, a ship's surgeon, who tried about the year 1791 to construct a telescope objective showing remarkably diminished chromatic aberrations, or, in our modern language, an insignificant *secondary spectrum* only.

Both these investigators had to recur for their experiments to fluid media, *i.e.*, pure water or solutions of different acids in water. In consequence of this drawback—fluid lenses not producing sharp images, owing to the striæ caused by differences of temperature—the work of these scientists, although of great theoretical importance, failed to improve the state of practical optics at that time.

The generally accepted necessity of employing solid optical substances only—different kinds of optical glass and natural crystals like pebble—sooner or later compelled practical opticians to direct their attention to the possibility of melting *optical glass*. Two different kinds were necessary, as Chester Moor Hall already knew: for positive lenses: crown glass with *low* refraction and *low* dispersion, and for negative lenses: flint glass with *high* refraction and *high* dispersion.

Whereas the supply of flint glass as furnished by the ordinary technical glass factories was neither sufficient nor perfect, so that the output of good telescopes especially of somewhat larger diameter was endangered, P. L. Guinand, a Swiss amateur glass founder, began to develop methods for melting *optical glass* apart from the ordinary *technical* rules; after many trials, he made in 1798 his first improved experiments in *stirring* the liquid contents of the crucible. By a very remarkable combination of circumstances he was, in 1805, engaged by the owner of a small Bavarian optical factory, so that he had to direct his energy to founding ordinary crown and ordinary flint glass for the manufacture of telescopes. Soon after he made J. Fraunhofer's acquaintance, who, towards the end of 1807, was the young foreman of this optical factory.

There is not room enough for entering here at some length into the interesting history of this famous optical factory and it must suffice to say that between August 1809 and December 1813 Guinand-Fraunhofer's important process for melting optical glass in sheets of considerable size was developed and put to the test.

Being sure of the technical solution of this problem Fraunhofer set to work—as it seems since the first days in 1814—to find the exact data necessary for introducing the optical qualities of any melting into his scientific calculations. In our modern way of expression we may say that in time he accomplished the task of exactly measuring the *refractive index* of every melting as well as its *dispersion*.

This, as a matter of fact, was the very aim striven after but missed by all scientific opticians from R. J. Boscovich's time downwards. After a not unsuccessful attempt with an instrument we should designate to-day as a *monochromator*, Fraunhofer hit upon the idea of using the dark lines of the solar spectrum so to say as unchangeable landmarks within the coloured band. We do not know the exact time of this application falling in between the beginning of 1814 and April 1817; its description formed a part of his important paper read before the Munich Academy in the spring of 1817. Seven of these dark lines had been described as early as 1802 by W. H. Wollaston, but this scientist made his observations by the naked eye and thought of using them simply as boundary marks between the regions of different colour.

Fraunhofer, with his splendid gift for observing and measuring, examined these lines by means of a theodolite of considerable magnification and was therefore, in 1817, able to publish an exact chart of the solar spectrum and to account for 574 dark lines, the most important of which he traced on

the chart. Later on he was able to determine the length of the corresponding light waves for seven of his most important lines ; and for more than 40 years these data remained the most exact values known.

But to return to the chromatic aberration : by means of the dark lines he could now exactly measure the partial dispersions and accurately verify Clairaut's supposition of 1762. In his important paper of 1817 he further demonstrated that for different pairs of optical media (fluids enclosed) the degree of this unwished for disproportionality was quite different. He concluded, there was the hope of founding pairs of optical glass types (fit to be used as crown and as flint) with a more or less proportionate increase of the partial dispersions. We shall, in the following, designate such a pair of optical glasses as answering to Fraunhofer's *postulate* for colour correction.

In his paper of 1817 he could describe such a pair as a remarkable approximation to the ideal solution. His two sample meltings were designated as Flint 13 and Crown M. He, however, refrained from introducing them at large, probably because the durability of these combinations was not sufficiently proved.

In order to show graphically the improvement brought about by Fraunhofer with regard to the better proportionality of the partial dispersions we shall apply a well-known method. As the length of the *complete* primary spectrum (say, from the red line B to the violet line G) caused by a prism of sufficiently small refractive angle is proportionate to this angle, we are—by judiciously choosing each of the refractive angles—able to prescribe a certain standard length (say, of 250 mm. or about 10 inches) for the complete primary spectrum of any glass melting. A certain pair of glasses being chosen to serve as the crown and as the flint lens of an achromatic telescope objective, we are therefore able to give the same standard length to each of the complete spectra.

In consequence of Clairaut's law the *partial* dispersions of crown and flint are then by no means equal, and the lengths, say, from B to C, from C to D, etc., will differ the more for both glasses, the greater the disproportionality existing in them. We shall see this at a glance, if we arrange the two spectra of standard length with their subdivisions so that the crown spectrum is above the flint spectrum.

The two drawings of Fig. 1 show very clearly a marked want of proportionality in a pair formed by ordinary crown and ordinary flint and the advantage gained by

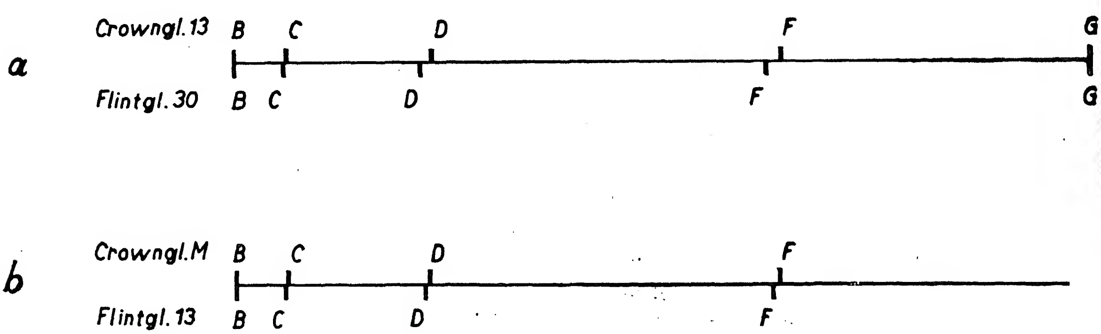

Fig. 1.

Representing the disproportionality of the partial dispersions in crown and flint.

a : Ordinary crown and flint according to FRAUNHOFER'S measurements.

b : FRAUNHOFER'S improved crown and flint according to FRAUNHOFER'S measurements.

Fraunhofer in this respect by the new pair formed of crown M and flint 13.

Fraunhofer did not desist from these experiments and in December 1823 he mentioned the fact of having achieved marked improvements in his sample meltings. But the data were then not given.

His premature death, on the 7th June of 1826, put an end to this really scientific management of the Bavarian optical factory. From numerous appreciations of his work—by English and French scientists also—we can to-day only infer his incomparable mastery respecting the optical problems of his time.

With reference to the diminution of the secondary spectrum the most remarkable instance of practical work between the efforts of Fraunhofer and those at Jena must be ascribed to the collaboration of M. V. V. Harcourt and G. G. Stokes from 1862 to 1871. In 1874 we even hear of a telescope objective with small secondary spectrum; in connection with this experiment the English glass works of Chance Bros. made, in 1874–75, an experiment with the Titano-silicic crown (on the suggestion of Prof. Stokes) on a large scale in the hope of having it employed for telescopes with reduced secondary colours. Although the result did not come up to expectations it must be noted here as the *first large melting of new glass* made with the object of placing practical opticians in a position to achieve sensibly better correction of their instruments.

The new impulse to colour correction given at Jena from 1871 onwards was independent of Fraunhofer's work as it resulted from scientific endeavours undertaken for the improvement not of the *telescope* but of the *microscope* objective. The new ideas were formed by E. Abbe, a young mathematician, who in 1870 successfully undertook the arduous task of following the rays from the object point through the microscope objective by means of trigonometrical calculation. He soon found the principal obstacle to a good correction to lie in certain chromatic aberrations completely different from the disproportionality of the partial dispersions in crown and flint, or, in other words, *different from the secondary spectrum.* Although in the total of chromatic aberration this effect due to the secondary spectrum was also present, it formed only an insignificant part compared with the other error, called by Abbe the *chromatic difference of spherical aberration.*

He soon directed his whole attention to this predominant part of the chromatic aberration. In order to form an estimate of the improvement given to the image by its annihilation or correction, he introduced into his trial systems some fluid media as lenses. They were, of course, enclosed by two glass lenses serving as a front and as a back shell. His trials of 1873 and 1876 showed an image vastly improved after removal of the chromatic difference of spherical aberration. Such fluid lenses were necessitated by his plan in so far as it was feasible to reserve one of the two inner or contact surfaces of the fluid lenses to combat the chromatic difference of spherical aberration alone. When reviewing his own work in 1893, he emphasised the theoretical progress achieved with these early trial systems containing fluid lenses in so far as the aim and the direction of Schott's great achievement in founding new glass types was already fixed by these purely theoretical experiments. Needless to say that these two systems with fluid lenses were never destined to be sold as ordinary microscope objectives; they were planned only for the instruction of both leading men, Abbe and Zeiss, by allowing them a glimpse of the microscope objective of the future.

He contributed an article to the two volumes of critical observations on the *Loan-Collection* of 1876 published by Hofmann in 1878, and he showed the real reason for the state of microscope optics as revealed

with the help of this instructive collection, by pointing to the far too restricted choice of glass types accessible to the practical optician. So he formulated *his new condition* for the correction of the chromatic difference of spherical aberration: new optical glasses are necessary, combining either low refraction with rather high dispersion, or high refraction with rather low dispersion. Abbe's *new condition* may also be expressed in the following manner: a glass of a certain dispersion being necessary, a freer choice for the refractive index should be open than with the old series of silicate glasses, where higher dispersion was always coupled with higher refraction and *vice versa*.

For a graphic representation of Abbe's theoretical postulate we shall insert a graph published in 1899 for showing up the advantage offered by the then new Jena glasses. In correspondence with Abbe's ideas, every melting in Fig. 2 is represented by a point

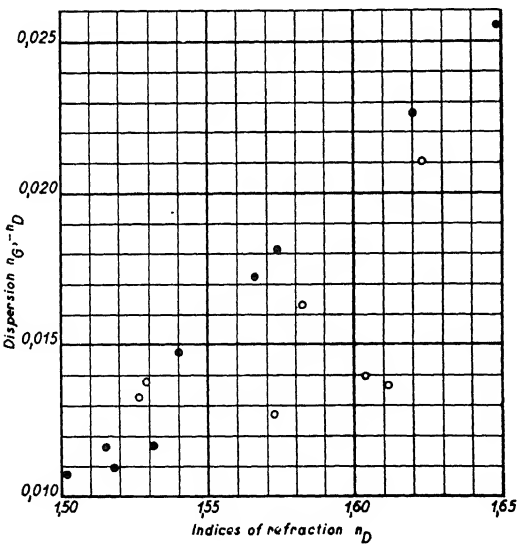

Fig. 2.

Graph illustrating ABBE'S postulate and its fulfilment by the new Jena glasses.

whose abscissa gives the mean refractive index $n_D{}'$ and the ordinate indicates the dispersion $n_{G'}—n_D$. (This special value was chosen, because in the book of 1899 the photographic objective had been treated.)

The series of old glasses (represented by dots) forms roughly a straight line; therefore, the dispersion being prescribed, the computing optician has no choice for the mean refractive index or *vice versa*. It is different with the new Jena glasses of 1886 and later (represented by circlets). Here a certain *area* is covered; in other words, a certain value of the dispersion (*e.g.*, 0·014) being given, the choice for the mean refraction is still open over a considerable interval (*e.g.*, $1·53 < n_D < 1·605$).

Abbe thought it possible in 1878 that scientific bodies in the different countries might successfully instigate their optical factories for working in this direction.

The actual development of the new ideas took, however, a different course: Abbe's article in Hofmann's collective volumes was itself the means of bringing him and O. Schott together. A new era in the making of optical glass was forming itself, as a mathematician knowing (as we said before) the direction and the aim of the intended progress was brought into contact with an energetic and highly inventive founder of glass. English readers may suitably remember the consequences of the joint work of Harcourt and Stokes on Fraunhofer's postulate. On two different occasions G. G. Stokes himself insisted on the importance of influences due to one partner on the other and *vice versa*.

With the successful Jena Glass-Works the case was similar; its great success cannot be ascribed to one of the two partners predominantly: it was a combined achievement due to their coalition.

As early as January 1881 they began to work unitedly, having always before their eyes the production of new glass types more or less similar in effect to the fluid media. Early in 1882 O. Schott took up his abode

in Jena and in March of the same year they prepared a report of the new hopes and expectations based on their extensive laboratory work in founding, measuring and discussing nearly a hundred different sample meltings. This report was virtually written for the Prussian Government, as a body willing to raise the mechanical arts in Germany to a higher level. It was very favourable for this plan that one of the higher officials concerned, W. Wehrenpfennig, was much impressed by Abbe's personality. State help was actually forthcoming (in two instalments of 25,000 and of 35,000 Marks equal to a total of about £3,000 at that time), so that the four leading men in Jena, Abbe, Schott, father Zeiss and his son, were able to erect a glass-works especially for new glass types. Needless to say that both postulates, the old one by Fraunhofer and the new one by Abbe, were considered; but it stands to reason that the principal endeavours at that time were directed towards the new postulate as a decided success in this direction was of vital importance for the microscope factory. Very soon, in the autumn of 1883, the first specimen of an *apochromatic* objective was ready, in other words a microscope objective *spherically corrected for two colours* and *free from secondary spectrum*. The correction of these two principal aberrations gave to the new form the advantage of a much sharper image able to bear a far greater magnification by the eye-piece. Other objectives were in the course of preparation and were tested in the next year.

The year 1885 was reserved by the new glass foundry for coming into touch with the practical opticians of the country and in July 1886 the concern was able to publish its first *Scientific Catalogue of Optical Meltings*. Many of them were new types and at the same time Abbe's new scheme for the scientific description of each melting was put into practice.

Nearly at the same date the complete series of the new apochromatic objectives was published; it proved what a judicious selection of new optical media could effect in combination with an equally well-directed calculation work.

Although Fraunhofer's first steps had been taken in the same direction more than 70 years before—and the work of Stokes and Harcourt may also range in this line—for the eighties the idea was quite new and in the retrospect even startling that in Jena the foundry and the optical works were—in a scientific sense—not independent of each other, but that the foundry acted on the hints given by the scientists conducting the extensive calculations.

So, later on, the heavy baryta crown glasses were markedly improved as the planning of the Jena anastigmatic allowed to infer their great economic future. A similarly wide appreciation was in store for the specially limpid boro-silicate-crown that was to be used extensively for the prism glasses from 1893 onwards. And in conclusion we may refer to the nearly ideal achievement of Fraunhofer's condition of higher achromatism, when the pair of glasses at first introduced as telescope crown and telescope flint was made available.

REVIEWS.

The Future of Marriage in Western Civilisation. By Edward Westermarck. (Macmillan & Co., London.) 1936. Pp. xiv + 281. Price 12*s*. 6*d*. net.

This work is a dispassionate and scholarly presentation of a subject, whose inherent interest holds a strong appeal not only to the social anthropologist but also to the general reader. The investigations of the author have led him to conclude that the family instinct is far too deep rooted in human nature to be eradicated, whatever vicissitudes might overtake the economic life of man, and therefore marriage as a social institution is bound to survive as a permanent feature of sex relationship. At the same time he has pointed out that divorce will become comparatively easier and that even sexual acts outside the conjugal limits would likely lose the moral censure and penal legislation, under which they are now laid. The author maintains that his conclusions are not based on the general tendencies of to-day, but that they have been reached from the assumed continuance of those feelings which trace the origin of marriage and family life, and the ingrained taste for variety in sex experience. It is true that when conjugal and parental sentiments should disappear as the result of reaction due to the increase of knowledge and stern economic necessities, then marriage and the family system also must vanish. The assumptions of the author possess a considerable degree of certainty so far as the near future is considered, and to that extent the main thesis of the book is indisputable.

The first chapter is devoted to examining the theories regarding the meaning and origin of marriage, and generally they account for the lasting association of the sexes on the assumption that in animals, more especially among the anthropoid apes, there is an uninterrupted sexual capacity. It is also pointed out that the marital and parental instincts seem to be necessary for the existence of certain species, and consequently the male and female of such species keep together after the breeding season, thus providing the necessary basis of marriage, which according to Westermarck's original definition is "a more or less durable connection between male and female, lasting beyond the mere act of propagation till after the birth of the offspring." Stripped of the accretions imposed upon it by the church and society, marriage is fundamentally the lending of a woman's body for the use of man who for the pleasure of it, supports her; it differs from prostitution in the fact that in the latter the leasing of the body is periodical and more than one man is involved. Marriage takes its origin not primarily from the sexual congress, but from the habit of man and animals leading a gregarious life for the purpose of protection, and breeding is subordinate to the more dominant concern of the safety of the group. A communal life with primitive instincts of protection implies the existence of promiscuous sex relationship, and the evolution of the family idea follows the shifting of man's allegiance from the community to the individual. The stabilisation of the family is based on the gradual discovery by man that it is capable of functioning as an efficient and self-contained economic unit, organised for self-protection, and the idea that exogamy materially increases the economic and defensive power of the family is perhaps the foundation of the cruder forms of social organisation. Where, however, animals are superiorly endowed, they have remained solitary, and their sexual association is fugitive, the female undertaking the protection and education of the offspring till the latter are sent into the world. Primitive man being defenceless, he must have banded himself into groups for protection from wild beasts and must have found common shelter against the inclemencies of weather, a mode of herd life best fitted for survival; and loyalty to the community being most advantageous in primitive life, is reflected in modern civilisation as social and racial instincts.

Whether promiscuity of sex relationship preceded or not the regulation of individual sex relationship in the human race, is not to be judged by the ethnic evidence based on researches of the surviving savage groups, but we should go back to their predecessors, for the existing savage tribes have been undergoing a process of development, though within a limited sphere, and as the result of this influence many of their customs and habits must have undergone a corresponding evolutionary change. No social anthropologist can maintain, that the existing

primitive groups have retained unaltered the picture of life as lived by their ancestors, however static such groups might appear to the more rapidly changing modern world. Professor Westermarck might perhaps agree with the views of Iwan Bloch and Briffault, if he should extend his researches into the condition of human existence immediately preceding the tribal organisations, before their bundle of customs, laws, superstitions and taboos came into existence.

The second chapter deals with the three essentials of normal marriage, *viz.*, sexual impulse, the relation between husband and wife apart from it, and procreation, which are all sources of much happiness. The chapter also includes a discussion on birth control and love on each of which opinion is bound to differ.

The subsequent chapters treat of subjects such as the causes of matrimonial unhappiness,—sexual maladjustment, adultery and jealousy, and they contain a wealth of information, which, while necessary for a comprehensive knowledge of these social problems, shows that no two anthropologists hold the same opinion. These topics cannot be treated on the rigid basis of the exact sciences and the conclusions cannot be expressed with any degree of mathematical precision and accuracy. The reason is obvious. The causes and factors which are investigated by the social anthropologists are too many and too diversified, besides being obscure, to be comprehended as the simple elements of a single physical or chemical phenomenon, and the nature of the subject therefore lends itself more for metaphysical speculation than experimental verification. Where questions of interpretation arise, there is always ample room for divergence of doctrines, and we shall briefly examine some of them. In Chapter XI there is a clever discussion of sexual behaviour and morality, and dealing with abnormal behaviour, Westermarck points out that "generally speaking there is a remarkable lack of inclination for sexual intercourse between persons who have been living closely together from the childhood of one or both of them. This has been recognised by various writers as a psychological fact proved by common experience, and is attested by statements from different parts of the world. Even among the lower animals there are indications that the pairing instinct fails to be stimulated by companions and seeks strangers for its gratification. This indifference is very generally combined with sexual aversion when the act is thought of,—aversions that are generally felt lead readily to moral disapproval and prohibitory customs and laws." This is the theory of incest. Westermarck, however, recognises that in ancient times kings and ruling chiefs permitted their children to marry each other with the aim of maintaining the purity of the royal blood. Historians and anthropologists inform us that during the early stages of the evolution of societies, ties of kinship which modern man treats with respect offered no impediment to sexual unions without any thought of the purity of the blood. It seems to us that the horrors of incest have been engraved on the human conscience with great difficulty and by a long process of education. Westermarck's observations on the lower animals may not be correct in their entirety, for in the gregarious animals brotherhood and sisterhood, which are distinctly human concepts, do not impose obstacles in the way of sexual attraction, and if the male and female members try to secure mates from the neighbouring herds, it is more with the object of adding more members to their community. If there were aversion, then the size of the herd would not grow. In the case of solitary animals, in which brothers and sisters are separated in an early period of life, it would be difficult to maintain that there is in them inherent aversion so as to prevent incestuous intercourse. Besides, is it a fact that there is a lack of inclination for sexual intercourse between persons who have been living close together from the childhood of one or both? We are disposed to think that this lack of inclination manifests at a maturer age, after the individuals have been educated at home, school, the church and society about the sacred character of kinship, the filial and parental duties, obligations and relationship, and during all this prohibitory period of education the sexual ardour between brothers and sisters is systematically and absolutely starved. The effect of such starvation and the influence of social opinion must produce indifference which is strengthened by the desire of gaining and maintaining the good opinion of the society to which the individual is introduced as a member. Is there an inherent aversion between sisters and brothers or is the close companionship a sufficient cause for producing it? It is

rather due to the vigilance and discipline at home, which, joined to the influence of the church and the public opinion of the society, renders the attraction so obsolete as to become incapable of being stimulated at a later period. The horror is not inborn as an integral part of the mental constitution. We can account for the savage communities giving up incestuous practice on the assumption that sooner or later they must have been led to the discovery that marriage of children outside the limits of kinship was an economic gain to the family, and its extension by ties of marriage gave additional strength both for offensive and defensive purposes. The moral idea may not have been at the root of this arrangement, and it was obviously imposed upon incest to reinforce the economic advantage gained by the new departure. We believe that the disapproval of such savage communities as do not practise incest, was the outcome of the stern economic necessities of primitive life, and aversion, in the sense in which Westermarck uses the term, must be foreign to them. The first part of this extremely interesting chapter (XI) is occupied with a clever and convincing exposition of moral concepts as ultimately based on one or the other of the emotions of disapproval and approval.

There are two factors which might militate against the attainment of uniformity in the moral sphere. These are the rapid growth of the economic independence among women and the increasing practice of birth control. The history of the last fifty years bears witness to the growing and continuous influx of women into wage-earning employment, and the effect of economic change on the moral sentiments on the one hand. and the continuance of dependence of women on mariage for livelihood on the other, must be far-reaching, unless counteracted by other forces which are at present obscure. Westermarck thinks that because the instinct of family life is part of the animal inheritance of man, marriage is bound to survive the modern economic revolution, but even from economic considerations it is perfectly arguable that in the distant future the marriage tie is likely to be relaxed, favouring the tendency to irregular unions, though Westermarck thinks that children will be the deciding factors of the continuance of marriage as a social and economic institution. The argument of children loses ground when we reflect on the influence of the extensive practice of birth control on morality.

In certain views advocated by Westermarck, there may be divergence of opinion, but nevertheless we cannot refrain from expressing our admiration of the candour and sincerity with which he has approached the problems, and the truly scientific spirit which characterises his discussion of them. The book will always be treated as a great contribution, and will be widely read with pleasure and profit.

Einführung in die Quantenmechanik. By Dr. E. Fues. Being a Reprint of the Theoretical Part of *Handbuch der Experimental-physik*, *Ergänzungs-Werk*, Vol. II. (Leipzig: Akademische Verlags-gesellschaft M. B. H.) 1935. Pp. viii + 224. Price Stiff Covers 14 R.M.

After a phenomenally rapid development, the subject of Quantum Mechanics has now reached a stage where its applications to the details of phenomena can be left to ordinary workers and the creators of science occupy themselves with examining the sufficiency of its foundations, its philosophical implications and the directions in which further progress is to be sought. Though the "Copenhagener Geist" inclines to further sacrifice of classical positions in the same direction in which Quantum Mechanics has progressed since its statistical character began to be more and more emphasised, Einstein considers the description of Reality it provides to be incomplete and Schrödinger himself seems to be dissatisfied with its prediction of uncertain values associated with well-defined instants of time. Some doubt is also being cast on the validity of the laws of conservation of energy and momentum in individual processes. The structure of Radiation is the subject of many different theories, and with it, the relation between the particles and waves of wavemechanics forms a chapter which does not admit of certain assertions or final views. At such a stage an exposition of the present position with emphasis on the implications and limitations of current methods is a great desideratum and the work of Prof. Fues eminently supplies the want. The publishers have rendered a service to many readers by thus re-issuing the work of one who was associated with Schrödinger in those eventful days when wave-mechanics was born and grew so rapidly, and making it available in this

handy and cheap form. For fourteen Marks we thus get a book packed with information and its possessor will not look in vain for instruction on any aspect of Quantum Mechanics except the insufficiently established and rapidly changing subject of Quantum Electrodynamics with its numerous, conflicting and only partially successful theories. Matrix methods, however, are not presented in any detail, the emphasis being naturally laid on Schrödinger's methods, but Dirac's theory of the electron and positron is given in detail and a good deal of space is devoted to the wavemechanics of systems and the approximation methods of Hartree for example. Heisenberg's work also has been freely drawn upon, particularly his "Physikalischen Prinzipien der Quantentheorie". Thus his beautiful discussion of the uncertainty principle in its application to various hypothetical experiments is fully summarised in a small number of pages. To save space, the main theory is given in ordinary print while details and examples are set in small type. Even with this device the compression necessary has sometimes been rather excessive. For example, the demonstration that a Gaussian distribution of errors is the one which leads to a minimum value for $\Delta p . \Delta q$ occupies two full pages in Heisenberg's book but is here compressed into a quarter of a page by quoting a few steps here and there. For the same reason mathematical results are freely assumed, *e.g.*, the method of determining the eigenwerte is not given in connection with the oscillator and the rotator. The polynomial method is, however, shortly illustrated in connection with the hydrogen atom. In fact, the notes in small type appended to the various sections provide an almost complete resumé of the applications of quantum mechanics to atomic theory. The diffraction of matter waves and impact phenomena form the subject of another chapter. Although originally appearing as an article in the *Handbuch der Experimental physik*, the volume is of even greater use in its new form. The present situation leads one to the hope that this volume may be supplemented by a second part in the way in which Born's *Atom-mechanik* was, fulfilling the prophecy he so happily expressed by calling his book of 1924 'Part I'. The printing and get-up are of the same uniform excellence which we associate with the *Handbuch der Experimental physik*. Our thanks are due to the Publishers for making this excellent work easy of reach to a wider circle of readers.

T. S. S.

The Chemistry of Synthetic Resins. By Carleton Ellis. 2 Volumes, Illustrated, Medium 8 vo. (Reinhold Publishing Corporation, New York.) 1935. Pp. 1615. Price £4–17–6.

The more exacting and descriminating demands of a flourishing industry offer the necessary stimulus for conducting research through which its requirements are satisfied. This process often leads to unexpected results of far greater importance than the one anticipated and incidentally opens out possibilities of creating newer products of far greater utility, and the field of synthetic resins is replete with innumerable examples of this kind.

The phenomenal growth of the finishing, the plastics, the insulating and the bonding industries during the past decade, has been entirely responsible for the vast amount of research that has been carried on and for the bewildering variety of resins which have been produced. This enormous research activity is reflected in the two monumental volumes on the Chemistry of Synthetic Resins under review.

The creation of the innumerable species of synthetic resins, a comprehensive literature survey of which is provided by the present work, has been rendered possible by the wide range of raw materials which have been harnessed in their production. Although every product synthesised in the test tube has not been commercialised, it has contributed towards systematising our knowledge of the causes and nature of resinification, a discussion of which appears in the earlier chapters of the first volume. The commercial success of a synthetic resin, however, depends upon the relative inexpensiveness and availability of the raw materials.

Each class of the resins has been systematically treated; the chemistry of their formation and the technology of their production are described in detail. This is followed by a description of its mechanical and electrical properties and its behaviour and adaptability as a raw material for various industries. Sufficient technical information has, therefore, been included in the volumes and has been presented in a manner so that an experienced and versatile industrialist will be stimulated to think of new applications of the product. Special attention has

been paid to the adaptability of the product for plastic moulding.

The volumes, therefore, constitute a thoroughly documented and highly authoritative fount of information on all that is to be known on the chemistry of synthetic resins and its technological applications.

M. S.

Comprehensive Treatise on Practical Mechanics. By J. M. Lacey, M.I.C.E. (The Technical Press, Ltd., London.) 1936. Pp. vi + 320. Price 18*sh.*

Books on Mechanics generally contain only the theoretical principles of the subject, while the application of these principles in actual practice is dealt with in treatises on Applied Mechanics. It was a happy idea of Mr. Lacey to combine these two aspects in his book *A Comprehensive Treatise on Practical Mechanics*.

The book is divided into two main parts, with an introductory first part dealing with the general laws of gravity, mass, force and velocity. Part two deals with the principles of statics, *i.e.*, of the action of forces on bodies at rest and part three treats of dynamics, *i.e.*, of the action of forces on bodies in motion. In both parts, the fundamental laws of Newton are taken as the basis from which the principles involved in designing framed structures, beams, masonry dams, fly wheels, etc., are evolved. A few more practical examples, such as those of the action of governors, on the effect of motion in a resisting medium, the action of springs, and constrained motion such as that ordinarily found in machines, would have made this volume more comprehensive. The book is carefully written and shows that the author has almost thoroughly mastered his subject. A study of the book will give the reader a good grasp of the fundamentals of Engineering—which, after all, is practical Applied Mechanics. The practical engineer, if he goes through the book, will find his time well spent, as it will give him the necessary theoretical knowledge for interpreting many practical problems in a reasoned way. It will be a good addition to his library.

K. B. K. R.

A Treatise on Screws and Worm Gear, their Mills and Hobs. By P. Carmac. (Chapman & Hall, Ltd., London.) 1936. Pp. xi + 138. Price 21*s*,

The book supplies a long-felt want by the designers of mills and hobs. Major portion of the book deals with the mathematical analysis of the properties of movement, helicoids and envelopes, which is necessary for the correct design of gears and hobs. An idea of the contents of the book can be obtained from the following extract from the preface to the book.

"The introductory chapters give the general properties of motion with special emphasis on screw motion, the envelopes of surfaces having screw motion, and the geometry of the helicoid. The application of the theory to the solution of technical problems on the standard forms of screw and worm thread is then proceeded with and the tool forms for their production are investigated. These include thread mills and hobs. Reciprocating rack cutters are examined as special cases of rotary cutters. By the analysis of screw motion into a pair of instantaneous rotations a relatively simple treatment of the subject becomes possible; the mill or hob conjugate to a given screw thread is determined by methods analogous to the familiar method of the instantaneous centre of rotation for conjugate tooth profiles in plane motion. The converse problem, the type of screw thread, generated by a given form of rotary cutter or hob, is also solved. In every case the curve of contact of cutter and screw is obtained. The discussions on worm threads are extended to spiral and helical gear teeth, hobs for spline shafts and polygon profiles and single position hobs. The book concludes with a chapter on worm gear contacts in which both graphical and analytical methods are given for the construction of the surface locus of contact of worm and worm wheel."

The book has been well written and illustrated with examples wherever necessary. It should find a place in all technical libraries.

E. K. R.

Organic Synthesis, Vol. XVI. Edited by J. R. Johnson. (Chapman & Hall, London; John Wiley & Sons, New York.) 1936. Pp. 104. Price 8*s.* 6*d.*

The present volume gives the preparation of 28 substances and in an appendix some later references to the preparations in the preceding volumes. Some additions and corrections for the previous volumes are also included. It is needless to say that the

present volume has maintained the high standard attained in previous volumes. 'Organic Syntheses' have now become indispensable for research laboratories all over the world. The appearance of a new volume is eagerly looked forward to, by organic chemists. The present volume will not disappoint them.

The volume contains the following preparations.—(1) Alanine; (2) 4-Aminoveratrole; (3) *n*-Butyl Nitrite; (4) *n*-Butyl Phosphate; (5) Coupling of *o*-Tolidine and Chicago Acid; (6) Sym.-Dimethylhydrazine Dihydrochloride; (7) Unsym.-Dimethyl hydrazine Hydrochloride; (8) 2, 5-Dimethylpyrrole; (9) 1, 4-Diphenylbutadiene; (10) Epichlorohydrin and Epibromo hydrin; (11) Ethyl Phenylmalonate; (12) Ethyl *n*-Tridecylate; (13) *n*-Heptoic Acid; (14) *n*-Hexaldehyde; (15) Isonitrosopropiophenone; (16) Methyl Benzyl Ketone; (17) Methylhydrazine Sulphate; (18) *p*-Nitrobenzyl Bromide; (19) 4-Nitrophthalic Acid; (20) 4-Nitrophthalimide; (21) Pelargonic Acid; (22) Phenanthrene-2- and 3-Sulfonates; (23) Phthalaldehyde Acid; (24) Phthalide; (25) Quinone; (26) Succinimide; (27) Tetrahydrofuran; (28) Sym.-Trithiane. The reviewer has already repeated one or two preparations, *e.g.*, that of succinimide and 4-nitrophthalic acid and found, as is usual with this series, that the yields are exactly as stated. The preparations like phenanthrene-2- and 3-sulphonic acids, pelargonic acid, isonitrosopropiophenone would be extremely useful in view of certain recent developments which require these as starting materials.

J. N. R.

Practical Problems in Botany. By W. W. Robbins and J. Isenbarger. (John Wiley & Sons, Inc., New York; Chapman & Hall, London.) 1936. Pp. 402. Price 10 *s.*

Botany, the science of plants, claims dominion over more than ninety-five per cent. of the living matter on the surface of the earth. It offers unbounded scope for a study which is both attractive and imposing for young people.

Opinions differ as to what should constitute an elementary course in Botany. It must be remembered that only a few of our Intermediate students can take up University courses. Several of them go to medical schools and colleges and an increasing number take up the study of agriculture, but there always remains a large residue of others, who have to stop their instruction entirely and merely add to the unemployed.

To the student in all these categories, except the first, it is urgent that the first course in Botany should serve as a general introduction to the subject—a respectable minimum that must form a part of the intellectual equipment of every educated citizen.

The authors have provided us with an excellent little book that meets this purpose admirably. As the title itself suggests, the plan of presentation is essentially practical and for a proper appreciation of the facts given in the book the student must do a considerable amount of practical work not only in the laboratory, but also in the garden and the field.

At the end of every chapter there is a small list of exercises and questions which force the student to do some of his own thinking, but in most cases the answer will come forth readily. For more serious students there is a useful list of references which appears to have been selected with great care.

Throughout the text there are suggestions and interpolations on the possibilities of improvement of the home environment based on an intelligent application of the knowledge of the principles of plant growth. Culture of indoor plants, vegetable and flower gardening, preservation of foods, bacteria and their relation to disease as well as soil fertility, all find their due share. In Chapter V there is a good discussion of the failure of flowers to set fruit and the last chapter gives a particularly atractive account of the ways in which plants affect the lives of man.

The reviewer read through the book with the greatest interest—almost at one stretch—and he shares the hope of the authors that, if properly used, it will lead the student to the development of the elements of scientific thinking and increase his personal efficiency by making him a more cultured citizen.

It is a little disappointing to find that in such a well-written text some of the illustrations are amateurish, but there can be no denying that a book like this should be recommended for collateral reading to all of our elementary students who, in the preparation for the inevitable examinations, often lose a great deal that they must know.

P. MAHESHWARI.

Zoology for Intermediate Students. By Vishwa Nath, M.Sc. (Panj.), Ph.D. (Cantab.), F.R.M.S. (Uttar Chand Kapur & Sons, Lahore.) 1936. Pp. iii + 495 + xvii, one coloured plate and 176 figures in text.

By the publication of Dr. Vishwa Nath's text-book of *Zoology for Intermediate Students* the beginners in the subject are now provided for the first time with a lucid and not very technical account of the common Indian "types" studied in almost all the universities of the country. The appearance of such books is commensurate with the increasing popularity of the subject in the university curriculum and its great bearing on the problems of agriculture, veterinary, animal husbandry, etc. Dr. Vishwa Nath is a gifted writer and being himself a lecturer to the Intermediate students of the Panjab University has exercised considerable care in not overloading the book with details not required by the beginners. For the sake of clarity he is obliged in places to give details but they are placed in smaller type so that the average students can pass over them in their first reading, while the brilliant students may benefit by the additional information provided in them.

The author has found from his experience of teaching that the following plan is very useful to initiate the beginners in the subject: "The preliminary lectures to the recruits should be on the meaning and scope of biology, properties of living objects, chemical and physical structure of protoplasm, physico-chemical conception of life, spontaneous generation, source of protoplasmic energy, saprophytism and parasitism, and a bare statement of the cell-theory and the cell. After this grounding in general and fundamental phenomena of life, the teacher might start lecturing on the types. A beginning may be made with the frog which, in spite of what has been said to the contrary, is still the most convenient principal type,—and then through *Amœba*, *Paramœcium*, malarial parasite, *Obelia* or *Hydra*, *Pheretima*, and Cockroach on to the Rabbit. Now will be the time to do principles of classification and a general survey of the main animal groups with special reference to ecology. The teacher might then revert to general zoology and deal with cytology, evolution and genetics, using his own discretion as to how much he has to say. For, in the author's view, general zoology has been dealt with in the book in some detail and this should make the book useful to the B.Sc. students."

The book is divided into 28 chapters, of which the first 10, comprising 123 pages, are devoted to general zoology. Chapters 11 to 26 give a treatment of "types" and of these 10 chapters are devoted to "Frog". The other types dealt with in the book are *Amœba*, *Paramœcium*, Malarial Parasite, *Hydra*, *Obelia*, Earthworm, Cockroach, and Rabbit. In the last two chapters, principles of classification and a general survey of the animal kingdom is given.

After a careful perusal of the book the reviewer endorses the view of Prof. George Matthai that "Students of Intermediate Zoology will find in this book a clear and concise statement of the essentials of Zoology."

S. L. H.

The Geological Map. By Kenneth W. Earle, D.Sc., F.G.S. (Methuen & Co. Ltd., London.) 1936. Pp. vi + 92. Price 3*s*. 6*d*.

This is a small hand-book of structural geology, with special reference to the study and interpretation of geological maps, intended for elementary students of geology and geography. Within the short space of about a hundred pages, the author briefly describes the various important structural features commonly noticed in rocks, giving actual examples from the geology of the British Isles. Pointed emphasis has been laid on important conclusions which the student has constantly to bear in mind while studying geological maps. The treatment of the subject is definitely of a practical character and the book is profusely illustrated, the chief method of illustration used being that of solid models which will greatly help the student to visualise geological structures "not only from the aspect of the surface map but also simultaneously in sections both in the directions of the dip and the strike of the strata". In his own words, the author's objective in writing these pages "has been to produce a book which, by the use of only the most simple language, and by the suppression of all superfluous detail, shall be intelligible to students of geography and geology alike"; and there is no doubt that he has succeeded in doing this. The general get-up of the book is excellent.

L. RAMA RAO.

Spiders of Lahore. By Sukh Dyal, M.Sc. (*Bull. of the Dept. of Zoology, Punjab University. Fauna of Lahore,* No. 4.) 1935. Pp. 119–252. Price Rs. 4–8–0.

The idea of publishing zoological bulletins embodying the results of study of Indian fauna is laudable enough but when the publication reaches a standard of the type attained by the volume under review, it becomes a distinct asset to Indian zoological literature. Mr. Sukh Dyal has attempted a task of immense difficulty and has creditably achieved it.

The material for the study has been collected from the town of Lahore and its outskirts and comprises 121 species belonging to 65 genera and 20 families. Of these 46 species are new to science. The author has deservedly paid great attention to the Attid group of spiders, which have received very meagre consideration at the hands of systematists in India and he claims to have discovered 16 new species in this family alone.

A useful account of the external anatomy of a spider is given at the outset followed by a key to the families of spiders found in Lahore. The species are treated in great detail. A useful glossary is given at the end, and also a complete bibliography. The illustrations are excellent and the get-up of the volume, printed at the Civil and Military Gazette, Lahore, leaves nothing to be desired.

We congratulate Mr. Sukh Dyal on his excellent achievement and hope that his work will stimulate zoologists in other provinces to engage in similar faunistic researches which would add to our existing knowledge of the different groups of animals.

B. R. S.

Cotton Research in India. (Being an account of the work done at the Indian Central Cotton Committee Technological Laboratory, 1924–1935.) By Nazi Ahmed, M.Sc., Ph.D., Director. (The Times of India Press, Bombay.) 1936. Pp. vi + 100. Price Rs. 2.

It was a happy idea on the part of the Indian Central Cotton Committee to have brought out in a semi-popular form this compendious account of the work in their Technological Laboratory in Bombay during the twelve years it has now been in existence. Started primarily to assist cotton breeders throughout India in their work of raising improved varieties by furnishing them with a correct assessment of the different strains in respect of their spinning value, the Laboratory has been steadily adding to activities so that its work now embraces many lines of research both of a fundamental nature as well as those of immediate practical value to the mill owner and the cotton trade in general. Seeing that a spinning test is still the final arbiter of the value of any cotton, the laboratory has been a necessary and most important auxiliary in the work of cotton improvement and its help has accordingly been extensively availed of by all the agricultural departments in India engaged in the improvement of cotton. In addition to the laboratory determinations of the length, fineness, strength and other qualities of the cotton fibre the valuation of the samples relates to large-scale spinning tests of the yarns on actual mill machinery under conditions that make the valuations not only precise but also more accurately comparable. The devising of methods to give a quantitative expression to the qualities of the cotton fibre and thus to eliminate the personal factor which now largely prevails in the valuations has indeed been the scope of this branch of the work. The studies with a view to arriving at a "prediction" formula for the value of a cotton from data relating to its fibre qualities may be selected for special mention in this connection and it is interesting to note that practically two among the fibre properties, *viz.*, the mean fibre length and the mean fibre weight per inch decide its spinning value, a fact which is of great practical interest to the cotton breeder. Tests and valuations for breeders have amounted to more than 1,600 and the huge increase in the areas under varieties like Banilla, Jayavant and the Verum selections and of the consequent increase in the profits of the cultivator are claimed as the result. A parallel to such fruitful co-operation can only be found in the improvement of wheat both in India and elsewhere on the results of milling and baking tests.

Studies have also related to the influence on the fibre of season, of irrigation and the moisture in the soil, and of manuring which last, however, needs to be pursued further as it deals with a controllable production factor. Quite a large amount of work has been done on problems of great practical interest to the

mills, such as spinning methods and technique, methods of storage of cotton, the injurious effect of adulteration on the quality of the yarn, the moisture content of baled cotton of different types, and the effect of temperature and humidity in the mills on the cotton and the yarn. A study to find out the limit of spinning performance of various Indian cottons, brings out the interesting fact that Cambodia Co. 1 may be spun up to 52's, and even up to 60's under special conditions.

Among the services of the Laboratory to the cotton trade in general we may mention the arrangement for examining and valuing samples submitted and the comparative valuation of the samples of average quality of the chief trade varieties furnished officially by the Mill-Owners' Association of Bombay at the beginning of each buying season which are, of course, highly appreciated. The law prescribing the entry of all American cotton only through the port of Bombay and its fumigation as a control measure against the cotton boll weevil is due entirely to the efforts of the Laboratory through whose agency all this work of fumigation is now being carried out. The book makes it amply clear that the Laboratory has been of great service to all the cotton interests in the country, the grower, the trader, and the mill-owner alike.

We venture to think in this connection that cotton research in India will soon have entered upon a new and more intensive phase to enable cotton to maintain its position against competition from its new rival, "staple" fibre. Just at present this is negligible but it is nevertheless a portent like the cloud now no bigger than a man's hand. Most extraordinary claims are made for it, many countries are exploiting it and, despite imperfections and high cost, even now there is a fair quantity imported into India; and if one recalls to mind how "rayon" was perfected, cheapened and popularised it cannot be difficult to visualise the time when "staple" fibre will become a formidable rival to cotton. The cotton industry will, in the coming struggle, have to rely on the resources of science much more largely and the Laboratory will be called upon to play a still more important rôle with its scope widened to include not merely the cotton fibre but many other products, the cotton plant as well.

A. K. Y.

CENTENARIES.

By

S. R. Ranganathan, M.A.

(*University of Madras.*)

Samuels, Edward Augustus (1836-1908).

E. A. SAMUELS, the ornithologist, was born in Boston, Massachusetts, on July 4, 1836. He inherited from his father his deep interest in outdoor life. During most of his career, he was employed in the Massachusetts State Board of Agriculture. His duties allowed him ample leisure for other pursuits. He spent his leisure in the study of birds and their habits.

HIS PUBLICATIONS.

He recorded the results of his observations in the *Reports* of the Board of Agriculture. Encouraged by the wide interest his results aroused, he brought out in 1867 his well-known book *Ornithology and Oology of New England*. The book was so good that the State purchased a thousand copies for distribution to the public libraries. The book went through several editions and the 1870 edition came out with the altered title *The Birds of New England*. It is rightly estimated that this book stimulated bird study in New England more effectively than any other publication of the period.

HUNTING WITH A CAMERA.

Another book of his entitled *With Flyrod and Camera* and published in 1890 broke new ground in another way. It is said that it was perhaps the first publication to suggest the hunting with a Camera instead of a gun.

CONCLUSION.

His wide interest in the bird life and the influence he gained through his publications led to his election as President of the Massachusetts Fish and Game Protective Association. He held this post from 1885 to 1891. During this period, he did much to improve the laws of the land relating to the protection of animals. Though he became blind in his old age, he continued writing to *Forest and Stream* till his death on May 27, 1908. Among his contemporaries, he was regarded as the best-informed man on the natural history of his country.

Mapes, Charles Victor (1836-1916).

C. V. MAPES, who was born in New York City on July 4, 1836, was endowed with a versatile and brilliant mind and a bent toward applied science. Even while he was a student at Harvard College, he had fitted up a laboratory in his own room. As the state of his health prevented his studying medicine, as originally planned, he took up work in 1858 in a firm of whole grocers. In the next year, he established a factory near Newark for the manufacture of agricultural implements and fertilisers. He also took over the management of his father's paper *The Working Farmer.*

MAPES'S FERTILISERS.

Mapes was a pioneer in scientific agriculture. His special field was agricultural chemistry. In 1874, he produced the first special crop manure. This was for potatoes. He contributed several informing articles on chemical manures to the *Reports* of the New Jersey State Board of Agriculture and to several agricultural periodicals.

CONCLUSION.

In 1877 he became Vice-President and General Manager of the Mapes Formula and Peruvian Guano Company and later became its President. For a while, the Department of Agriculture of the Federal Government utilised his services in soil tests. He died on January 23, 1916.

Eastman, John Robie (1836-1913).

J. R. EASTMAN, the American astronomer, was born in Andover on July 29, 1836. He got his M.Sc. degree from the Dartmouth College in 1862. Shortly after this, he was appointed assistant astronomer at the Naval Observatory. In 1865, he became professor of mathematics and continued to be so till 1898.

CATALOGUE OF STARS.

He was an intimate associate of the astronomers, Newcomb and Hall. His contributions added not a little to the reputation of the Naval Observatory. From 1872 to 1882, Eastman was the editor of the publications of the Observatory. But the chief work of his life is the monumental volume entitled *Second Washington Catalogue of Stars*, which came out in 1898. It embodies the observations of several years with the meridian circle.

He was engaged in total solar eclipse expeditions in 1869, 1870, 1878 and 1882. He also took part in the determination of the longitudes of certain places in the United States.

CONCLUSION.

At various times, he was President of the Philosophical Society of Washington and of the Washington Academy of Sciences. He was also Vice-President of the American Association for the Advancement of Science. In addition to his astronomical contributions, he published in 1910, a book of considerable genealogical value, entitled *History of the Town of Andover*. He died on September 26, 1913. He contributed 21 articles to the scientific periodicals of the nineteenth century, his first paper entitled *On the Altitude of Kearsage Mountains in New Hampshire* having appeared in 1869 in V. 48 of the *American Journal of Science.*

Pickel, Ignaz Balthasar (1736-1818).

IGNAZ PICKEL, the German Jesuit and mathematician, was born on July 30, 1736. He was professor of mathematics in the University of Dillingen, which was then the intellectual centre of Catholic Germany, though it was dissolved in 1804. His first book entitled *Elementa arithmeticæ algebræ ac geometriee, etc.*, 2 T, 1771–72, was a popular text-book in Germany and went through several editions. He wrote nine other books. The Royal Society's index lists two of his papers. He died on October 16, 1818.

The London Shellac Research Bureau.

By Lal C. Verman, M.Sc., Ph.D., F.Inst.P.

SINCE 1929 the Indian Lac Cess Committee has maintained in London a Special Lac Inquiry Officer to provide the necessary liaison between lac producing interests in India and lac consumers in England, Europe and America. In this way a large amount of technical information, including a comprehensive bibliography, has been collected, and a number of the problems confronting consumers of lac have been examined in the light of modern conditions. It soon became apparent that the study of problems arising out of the application of lac could be best carried out near to the centres of consumption and that a research laboratory located in London would be able to provide that necessary service which consumers to-day expect. Consequently in 1933, the Indian Lac Cess Committee founded the London Shellac Research Bureau under the chairmanship of the High Commissioner with an Advisory Committee, the Special Officer, Lac Inquiry, and three Indian scientists, two of whom were chemists and one a physicist.

In the past three years the activities of the Bureau have been manifold. Some description of the work done will be found in the *Annual Reports* of the Special Officer (Mr. A. J. Gibson) but the present writer is mainly concerned with indicating and commenting upon some of the research work carried out by the staff. After a short time together at the Paint Research Station, Teddington, one of the chemists (Dr. A. Karim) was posted to Mr. Bayley Parker at the Research Laboratories of the British Thomson-Houston Co., at Rugby, and his work has been mainly concerned with the development of a buying specification for lac products in the electrical industries. to be approved by the International Electrotechnical Commission Advisory Committee No. 15, of which the Special Officer, Lac Inquiry, is chairman. This has involved a mass of research and analyses by standardised methods, work which is approaching completion. Dr. Karim has also compiled a monograph of general interest discussing the various problems of lac chemistry.[1]

The other chemist (Dr. R. Bhattacharya) and the physicist (the writer) remained at the Paint Research Station and have worked in close collaboration with each other at this Station, Teddington, of which Dr. Jordan is the Director.

The first work was to collect and consider the value of the published work on lac; in this way much valuable data have been presented in its proper perspective. Some of it has already been published in the form of critical summaries [2,3,4,5,6] but a considerable amount of material still remains to be presented in similar form. The current literature on lac has been continuously abstracted and printed as a special section of the Paint Research Station bimonthly *Review*. These abstracts are reprinted semi-annually in a collected form by the London Shellac Research Bureau.

The numerous enquiries received from lac consumers and dealt with during the three years cover a large field of application; some of the objects treated, included the preparation and testing of lacquers and finishes for various purposes such as artificial leather and leather goods, tin and aluminium foils, rubberised fabric; the study of processes for dewaxing of lac and the impregnation of cotton covered copper-wire; the production of cellulose-lac combinations; the testing and evaluation of new plasticisers and the study of problems arising out of the thickening of lac-copal solutions, and the manufacture of adhesive compositions. The general impression gained from these enquiries is that the consumer is anxiously waiting for convenient methods of increasing the softening point of lac and improving its water resisting qualities. These fundamental problems, so often referred to in lac literature, and others have received close and critical attention at the Teddington laboratories with a certain measure of success.

In dealing with any material, the first question and one of fundamental importance is "constitution," a thorough knowledge of which is absolutely necessary before any *systematic* study can be made leading to modifications showing improved and desirable properties. Some years ago Dr. Werner Nagel and his colleagues isolated and identified in lac two major acids—aleuritic and shellolic, although the correct formula for the latter is still uncertain. Dr. Bhattacharya's work[7] in this direction has revealed that the former can be easily isolated and purified, whereas the latter being very sensitive to the usual chemical reagents is difficult to obtain in a pure state. There are indications that this acid lactonises readily and indeed it has been found to exist in more than one isomeric form. He has, however, worked out a simple method[8] to isolate and purify shellolic acid, which depends on the relative solubilities of the lead salts of the lac acids in water. From the study of these comparatively pure materials it is evident that the iodine value of lac resin must be attributed to some component other than shellolic acid and not yet identified. This work and other related investigations have led to the derivation of a tentative monomeric formula for the major resinous constituent of lac—pure lac resin, which agrees with most of its known experimental constants.[9]

It has been known for a long time that shellac resin contains a hard and a soft component, the latter being ether-soluble. The work of Tschirch

[1] A. Karim, *J. Oil & Col. Chem. Assoc.*, May 1935, **18**.

[2] R. Bhattacharya, *Lond. Shellac Res. Bur. Tech. Paper*, June 1935, No. 2.

[3] L. C. Verman, *Lond. Shellac Res. Bur. Tech. Paper*, July 1935, No. 3.

[4] L. C. Verman, *Lond. Shellac Res. Bur. Tech. Paper*, Aug. 1935, No. 4.

[5] L. C. Verman, *Lond. Shellac Res. Bur. Tech. Paper*, May 1936, No. 7.

[6] L. C. Verman, *Lond. Shellac Res. Bur. Tech. Paper*, to be published shortly.

[7] R. Bhattacharya, *J. Soc. Chem. Ind.*, March 22, 1935, **54**. Also *Lond Shellac Res. Bur. First Bull.*, March 1935.

[8] R. Bhattacharya, *Chem. and Ind.*, April 17, 193 **55**, 309.

[9] L. C. Verman and R. Bhattacharya, *Lond. Res. Bur. Tech. Paper*, to be published shortl

and Schæffer, Harries and Nagel and others has, in a general way, indicated that the harder ether-insoluble component is chiefly responsible for the excellent properties of shellac. Our recent work has substantiated this view,[10] and the various means of isolating this hard component, which constitutes about 75 to 80% of lac, have been investigated[11]; of the methods available it has been found that a direct solvent extraction process is not only practicable and advantageous in several respects but is also likely to be a commercial possibility.[12] A semi-industrial scale pilot plant was constructed last year and the experience gained has brought the process to a stage where it can well be taken up by an industrial organisation.

The properties of this material, which has been named "Hard Lac Resin" in preference to the term "Reinharz," have been investigated in great detail[13] and it has been found to be superior to the parent lac in almost all respects. For example it is higher melting, is much more water-resistant, much quicker heat-hardening, possesses a higher degree of adhesive properties, yields harder and more flexible films, whilst the solvent retention of its films is negligibly small. In one respect, colour, it is inferior to whole lac; it can, however, be decolorised to a considerably greater extent than lac by means of a little oxalic acid or the like. It can also be bleached like ordinary lac, although this process has not yet been fully investigated. Furthermore, as it does not react with copper, no green discoloration is produced as is the case with lac under certain conditions. Other properties which make this material highly suitable for electrical insulation work are its higher breakdown voltage and its capacity to withstand high temperatures for prolonged periods of heating.

A general survey of the known physical properties of lac has indicated the need for a more detailed and systematic examination of most of them, especially those properties that are immediately important from the point of view of industrial application of lac. Investigations in this direction have yielded extremely interesting results of technical as well as theoretical importance. The following subjects have thus far reached the first stage of publication:—

(1) DARKENING OF LAC SOLUTIONS AND THE EFFECT OF OXALIC ACID THEREON.[14]

It is well known that lac solutions stored in tinned iron containers have a tendency to discolour with time and it is also well known that a small proportion of oxalic acid added to the solution has an inhibiting effect on this process. So far, no satisfactory explanation has been known for this phenomenon, nor has it been possible to determine the necessary amount of acid required to produce the effect. Our studies have revealed that on addition of acid to lac solutions the electrical conductivity of the latter decreases at first, passes through a minimum and then slowly rises. By a complicated series of conductivity measurements it has been shown that the minimum conductivity point, which varies from sample to sample between concentrations of about 0.025 and 0.25% of acid on lac, is definitely related to the anti-corrosive action of oxalic acid. The mechanism appears to be that the addition of acid precipitates the inorganic impurities in shellac as oxalates, which causes a depression in conductivity. A slight excess of acid over and above the minimum conductivity point helps to establish an equilibrium between the corroding iron surface, oxalic acid and iron oxalate, which is formed in preference to iron-shellac salts. Such an equilibrium prevents the weaker shellac acids from reacting with iron and thus preventing the darkening of the solution. This mechanism seems to explain the known facts for example of conductivity, but the necessity for further work in this direction still exists. It may also be mentioned that the amount of oxalic acid required to give the minimum conductivity to shellac solutions is also the amount necessary to cause the maximum possible decoloration of the solution, so that either electrometric or colorimetric methods can be used to determine the necessary amount of acid for the purpose of inhibiting the darkening of solutions in tinned iron containers.

(2) PLASTICISING OF LAC FILMS.[15]

The problem of finding a suitable plasticiser and that of comparing various available plasticisers for lac films has been a subject of controversy for some time. A preliminary study of the literature at once indicated that the chief reason for this controversy had been the lack of a systematic study. A comprehensive plan was drawn up, therefore, to study ten well-known and commonly employed plasticisers. The underlying idea of the scheme was to investigate all the properties dependent on plasticising action and to compare the results with the control as well as among themselves. The properties of the film so far studied are:—

1. Tensile strength.
2. Extensibility.
3. Adhesion to metal surfaces.
4. Water-sensitivity including blushing and amount of water absorbed by
   (a) detached films,
   (b) films on metal supports.
5. Effect of baking on these properties.

Other properties that may be included in the scheme are:—

6. Permeability to water and water vapour.
7. Durability under alternative exposure to dry and moist atmospheres.
8. Durability under normal as well as artificial weathering.

A good plasticiser should prove satisfactory in all these respects. So far, it has been found that among those tested sextol phthalate is the most satisfactory all-round plasticiser for lac.

(3) HARDENING OF LAC.[13]

In moulding practice, knowledge of the hardening properties of the material is essential and it

[10] L. C. Verman, *J. Soc. Chem. Ind.*, March 22, 1935, **54.** Also *Lond. Shellac Res. Bur. First Bull.*, March 1935.

[11] L. C. Verman and R. Bhattacharya, *Lond. Shellac Res. Bur. Tech. Paper*, Dec. 1934, No. 1.

[12] L. C. Verman and R. Bhattacharya, *Lond. Shellac Res. Bur. Tech. Paper*, Aug. 1935, No. 5.

[13] L. C. Verman, *Lond. Shellac Res. Bur. Tech. Paper*, to be published shortly.

[14] L. C. Verman and R. Bhattacharya, *Lond. Shellac Res. Bur. Tech. Paper*, May 1936, No. 8.

[15] L. C. Verman and R. Bhattacharya, *Lond. Shellac Res. Bur. Tech. Paper*, June 1936, No. 9.

is to be noted with regret that very little is known about lac in this respect. Our efforts so far have been confined to the study of time and temperature relationships in respect of hardening. It has been found that " Life of Lac under Heat " which means the time of heating necessary to reach the beginning of the " B " stage of polymerisation or rubbery, highly elastic state, can be expressed by the equation :—

$$l = ae^{-\alpha\theta} \quad .. \quad .. \quad .. \quad (1)$$

where l is the " life" in minutes,
θ is the temperature in °C.,
and a and α are characteristic constants.

The constant a seems to vary from sample to sample, while α is found to be more or less the same for most lac samples and even for hard lac resin it is only slightly different.

Furthermore, no appreciable insolubility of lac in alcohol takes place before the "life" has been spent ; thereafter insolubilisation proceeds at a rather rapid rate reaching a maximum of about 70-75%, corresponding to the proportion of the pure or hard lac resin component of lac. Then the rate again becomes very slow.

Data obtained by other investigators have also been analysed in the light of the above discoveries. The splitting away of water during the hardening of lac has been connected with the fact that the chemical reactions that take place are chiefly of the condensation type.

(4) VISCOSITY OF LAC AND HARD LAC RESIN SOLUTIONS.[16]

Studies of viscosity also leads to a simple empirical relationship between viscosity and concentration, *i.e.*,

$$\eta = \eta_0 \, e^{kc} \quad .. \quad .. \quad .. \quad (2)$$

where η is the viscosity of the solution at a given temperature,
η_0 is the viscosity of the solvent at the same temperature,
c is the concentration in terms of gm. of lac per c.c. of solvent,
and k is a characteristic constant.

The constant k is found to vary very slightly from sample to sample but appreciably with temperature. It is slightly greater for hard lac resin than for whole lac, the theoretical implications of equation (2) are unknown, but the variation of k with temperature indicates the formation of aggregates in solution. Equation (2) applies from the lowest concentration to the highest investigated (*i.e.*, from 0.5 to 50%).

Another useful relationship that emerged from these studies was the simple correlation of densities of solutions with their concentrations, expressed as :—

$$\text{Density} = \frac{\text{Wt. of lac} + \text{wt. of solvent}}{\text{Vol. of lac} + \text{vol. of solvent}} \quad .. \quad (3)$$

The practical usefulness of equations (2) and (3) is self-evident.

Among the numerous chemical modifications studied, two of them have so far proved to be of considerable technical importance : sulphitation of lac[17] and drying oil-lac compositions.[18]

It has been found that lac can be dispersed in water by the aid of sulphurous acid and alkaline bisulphites. Sulphurous acid dispersions yield water-proof films in which lac appears to be in the "B" stage of polymerisation, while bisulphite-dispersions may be made water-proof by pigmentation to form distempers. In both cases, a reaction appears to take place between the dispersing agent and the hard lac resin component. Large-scale experiments are in progress to test the utility of distempers thus prepared.

Since no other natural or synthetic resin reacts in this manner with sulphurous acid, it appears that the sulphitation process may be successfully developed as an identification test for lac.

The difficulties of dispersing lac in drying oils have long been known but they have been overcome by an ingenious process developed by Dr. Bhattacharya. Lac, bleached lac and even polymerised lac have been found to be easily soluble in fatty acids at moderate temperatures. Such solutions esterified with glycerol yield low acid value and normally drying oil-lac varnishes, which may be pigmented and tinted to give normal oil paints. One most important feature of lac-oil varnish is that it can be combined with cellulose lacquers in any proportion. Thus it is possible to combine in one vehicle the properties of cellulose (high gloss, quick drying, etc.) of lac (hardness, good adhesion, etc.), and of oils (flexibility, weathering, etc). Paints made from such combinations have been found to be highly satisfactory.

The completely esterified product of lac and fatty acids yields a product which, when neutralised with aqueous ammonia, provides a basis for emulsion paints and varnishes. Such emulsions have been used as binding media with various materials to prepare special surfaces.

In conclusion, it may be added that the work of the London Shellac Research Bureau has only just begun and judging from the present state of developments it is not unreasonable to conclude that the future holds unknown and great possibilities. The programme of researches in hand is very comprehensive and with the co-operation of the Indian Lac Research Institute and the United States Shellac Research Bureau, effected through the office of the Special Officer, Lac Inquiry, considerable progress may be expected in the near future.

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[16] L. C. Verman, *Lond. Shellac Res. Bur. Tech. Paper*, to be published shortly.

[17] R. Bhattacharya and L. C. Verman, *Lond. Shellac Res. Bur. Tech. Paper*, Jan. 1936, No. 6.

[18] R. Bhattacharya, *Lond. Shellac Res. Bur. Tech. Paper*, to be published shortly.

RESEARCH NOTES.

MATHEMATICAL AND PHYSICAL SCIENCES.

New Foundations of Projective and Affine Geometry.—Karl Menger (*Annals of Math.*, 37, No. 2, 456–482) has given a very systematic foundation of projective and affine geometry by means of two operators. It is of complete logical character—except for the independence of the axiom-systems which is not gone into by him in the present paper. The essential differences between his new treatment and the usual treatments are the following: (1) all the entities that are introduced belong to one class contrasting with the theory of Hilbert; (2) He does not derive new entities from the entities already defined—in contrast with the treatment of Veblen and Young given in their classical treatise. It is very interesting to note that the difference between projective and affine geometry *w.r.t.* their axiom-systems is brought out very clearly in this new foundation. The idea of dimension appears later.

Menger introduces two operations and a class of entities—A.B and A + B. [A.B ≡ corresponds to the highest dimensional part which is part of A and B—A + B ≡ the least dimensional part which contains A and B.] The following 4 postulates constitute those of projective geometry: (1) The operations are associative. (2) The space (*i.e.*, the totality of entities) contains a class V and another class U satisfying the relations V + A = A, and U.A = A. (3) A + (A + B).C = A + (A + C).B and A.(A.B + C) = A.(A.C + B). This postulate—which contains the commutativity of the operations appears to be the most charcteristic of the system. Part of it is satisfied by the entities of affine geometry also. This gives us a clear insight into the difference between the two geometries. (4) [A $\leqslant$ B means B contains A]. If A $\leqslant$ B $\leqslant$ C, there is a $\bar{B}$ such that B + $\bar{B}$ = C, and B.$\bar{B}$ = A. From these various theorems are derived such as the following—The operations are commutative—The relations A + B = B and A.B = A are equivalent. The point-concept is introduced. [P is defined to be a point if it has no part other than itself and the zero-element V] and various theorems concerning the relationship of the entities with points are derived, *e.g.*, if A $\leqslant$ B $<$ A + P, then A = B etc.

It is to be noted that with the interchange of + and ., V and U, and the interchange of 'contains' and 'is contained in', the axiom-system does not change. [The dual of a point is a hyperplane defined by means of U.] Hence the corresponding dual theorems also are true. Next he gives the common set of axioms of projective and affine geometry. They consist of the axioms (1), (2) and (4) and three others which are deductions of postulate (3). They are (*a*) The two operations are commutative, (*b*) The operations are absorbent. *i.e.*, A + A.B = A = A. (A + B)—this is equivalent to the equality of A + B = B and A.B = A. (*c*) If P is a point and P $\nleqslant$ A + B, then A.B = (A + P). B. With the exclusion of (*c*) every one of the axioms is self-dual. The dual of (*c*) is the following (*c'*). If H is a hyper-plane and H $\ngeqslant$ A.B, then A + B = A.H + B. It is easily seen that (*c'*) is satisfied in projective geometry and not in affine geometry. (*c'*) can be broken into two parts c_1 and c_2, the former alone being valid in an affine space (c_1). If H $\ngeqslant$ A.B and A.H≠V, then A + B = A.H + B. (c_2) If H $\ngeqslant$ A.B and A.H = V, then A + B = A.H + B. We can also divide (*c*) into two corresponding parts both being valid in both geometries.

The notion of independece of points is introduced—*i.e.*, P_1, P_2, ... P_n are independent if $P_k.(P_1 .. + P_{k-1} + P_{k+1} + \ldots P_n) = V$ for all k. He proves the fundamental theorem that if A is the sum of a finite number of points then it is also the sum of a finite number of independent points. This paves the way for the introduction of dimension of an entity A = μ^+ (A) as the number of independent points (assumed to be finite) constituting A. [Similarly the dual $\mu^\cdot$ (A) is introduced. The dimension of A, *viz.*, dim A is defined to be $\mu^+(A) - 1$.] The properties of $\mu^\cdot$ (A) in projective and affine systems are naturally different. In order to make the class, one of finite dimensions, he introduces another axiom—*i.e.*, that each strictly monotonic sequence of entities is finite. With projective axiom-system the following known properties of dimension are derived (1) dim V = −1, (2) dim A = 1 + Max. dim A′ for all A′ $<$ A. (3) dim A + dim B = dim A.B + dim (A + B). Next the deductions of axioms of alignment and extension of Veblen and Young are derived. [*i.e.*, the inter-relations between line and points.] An entity A is termed degenerate if there is a line L $<$ A, containing exactly two points and non-degenerate otherwise with the introduction of this concept the following fundamental theorem is of interest.—A finite projective space is the sum of a finite number of Maximal-non-degenerate elements (for details refer to the paper).

Next he comes to an affine-space. The equivalent of Euclid's parallel postulate is the following:—

If P, Q, R, are three points, no one of which is part of the sum of the two others, then there exists exactly one entity L, such that R $<$ L $<$ P + Q + R and L.(P + Q) = V.

Lastly it is interesting to note that the operations are not distributive. [The distributive property was already shown to be equivalent to the uniqueness of the inverse-operations by Schroder-proofs by Huntingdon—*Trans. Am. Math. Soc.*, 1904, p. 288.] The only results in this direction which can be derived from the four postulates are the following:—

(1) A.(B + C) $\geqslant$ A.B. + A.C. and A + B.C. $\leqslant$ (A + B) (A + C).

K. V. I.

* * *

On Some Extremal Properties of Polynomials.—J. Geronimus (*Annals of Math.*, 37, No. 2, 482–517) has investigated the problem of the extreme values of $\omega(P) = \sum_0^\beta a_r A_r$, $s \leqslant n$, for all polynomials $P(x) = A_0 x^n + \ldots A_n$ subject to one of the following conditions: I. $L(P) = \int_{-1}^{+1} |P(x)|\, dx = 1$. II. $\int_{-1}^{+1} |P'(x)|\, dx = 1$. III same

as II with the additional restriction that $P(x)$ is monotonic in the interval. Particular cases of this problem were solved earlier by Korkine, Zolotareff, Fujiwara and Bernstein. In case $s \leqslant \left[\frac{n}{2}\right]$, the extremum is reduced to that of the solution of a secular equation of degree $\leqslant (s+1)$.

First of all it is shown that in case of the extremum $P(x)$ should have all its roots $\eta_1, \eta_2, \ldots \eta_n$ (ascending order of mag.) between 0 and 1. The problem is transformed by writing

$$P(x) = \sum_0^n B_i\, U_{n-i}(x),\ U_k(x) = \frac{\sin[(k+1)\theta]}{\sin\phi},\ \phi =$$

arc cos x. Let $\omega(P) = \Sigma\, b_i\, B_i$, where the B_i's can be expressed linearly in terms of the a's. The relation between them is best expressed in terms of two auxiliary polynomials $\phi(x)$ and $\psi(x)$ whose roots are $\eta_1, \eta_3, \eta_5, \ldots$, etc. and $\eta_2, \eta_4, \ldots$, etc. respectively; *i.e.*, If η is odd then

$$\operatorname{Log}\left\{\frac{z - z^{-1}}{2}\ \frac{\psi[\frac{1}{2}(z+1/z)]}{\phi[\frac{1}{2}(z+1/z)]}\right\}$$

$$= -\frac{1}{\lambda}\sum_0^s \frac{b_i}{Z^{n-i+1}} + \frac{1}{Z^{n+2}}$$

and a suitably altered expression in case n is even, where $\lambda = \frac{\omega(P)}{L(P)}$. In case $s \leqslant \frac{n}{2}, b_{s+1} = b_{s+2} = \cdots b_n = 0$ and the previous relations are considerably simplified. Next he shows that

$$\phi\left[\frac{z+z^{-1}}{2}\right] + \tfrac{1}{2}(z+z^{-1})\psi\left[\frac{z+z^{-1}}{2}\right] = z^{v-s}\, q(z)$$

where $q(z)$ is a polynomial of degree s with real coefficients. $v = \left[\frac{n+1}{2}\right]$. With this analysis the problem is reduced to that of finding these coefficients. In the case when $s \leqslant \frac{n}{2}$, this involves the solving of a secular equation. He also derives a number of results concerning the roots of extremum polynomials. Various particular cases and the asymptotic nature of the extremum in particular cases are determined. The following are interesting examples.

(1) If $\int_{-1}^{+1} |B_0\, U_n(x) + B_1\, U_{n-1}(x) + \cdots B_n U_0|\,dx$

$= 1$, then $|B_s| \leqslant \frac{1}{2},\ s \leqslant \frac{n}{2}$.

(2) If $\int_{-1}^{+1} |P(x)|\,dx = 1$, then $|a_0 A_0 + a_1 A_1|$ $\leqslant 2^{n-2}\ [\,|a_0| + |a_0{}^2 + a_1{}^2|^{\frac{1}{2}}]$, the polynomial for which the extremum is attained being $k^2 U_n(x) + 2k\, U_{n-1}(x) - U_{n-2}(x)$ where

$$\pm k = \frac{|a_0| + |a_0{}^2 + a_1{}^2|^{\frac{1}{2}}}{a_1} \text{ and } \left|\frac{k}{a_0}\right| = \frac{k}{a_0}.$$

(3) If $\int_{-1}^{+1} |P(x)|\,dx = 1$, then $|A_0| \leqslant 2^{n-1}$,

$$|A_2| \leqslant 2^{n-4}[n-1+(n^2-2n+5)^{\frac{1}{2}}],$$
$$|A_3| \leqslant 2^{n-5}[n-2+\sqrt{(n^2-4n+8)}].$$

[Exact constants.]

In the general case when n is odd the extremum is the root of largest modulus of the equation (in μ).

$$\begin{vmatrix} \sigma_0\, \sigma_1 \ldots \sigma_\nu \\ \sigma_1\, \sigma_2 \ldots \sigma_{\nu+1} \\ \\ \sigma_\nu \sigma_{\nu+1} \ldots \sigma_{2\nu} \end{vmatrix} = 0,$$

where

$$\frac{1}{\sqrt{x^2-1}} \exp\left[\frac{\mu}{2}\sum_0^n \frac{a_k}{x^{n-k+1}}\right]$$
$$= \frac{\sigma_0}{x} + \frac{\sigma_1}{x^2} + \frac{\sigma_2}{x^3} + \ldots$$

It is easy to transform II to I by introducing suitable multiples of A_k. In the case of III he has shown that $\bar{P}(x)$ should be of the form

$$\int_{-1}^{x} (1-x)^\alpha\ (1+x)^\beta\, U^2(x)\,dx, \text{ where } \alpha, \beta = 0, 1.$$

Putting $u(x) = \sum_0^m a_i\, P_{n-i}(x)$. $n = zm + \alpha + \beta + 1$ where the P's are the normalised Jacobi polynomials for the Kern $(1-x)^\alpha(1+x)^\beta$. He derives $L(P') = \sum_0^m a_i{}^2$ and $\omega(P) = \sum_0^s \sum_0^B a_i\ a_k\ B_{ik}$, where

$$B_{ik} = \frac{(-1)}{2\pi i}\int_\Gamma \left(1-\frac{1}{x}\right)^\alpha \left(1+\frac{1}{x}\right)^\beta P_{n-i}(x)$$
$$\times P_{n-k}(x) \sum_0^s \frac{a_r}{(n-r)x^{2n-r}} \cdot \frac{dx}{x}$$

where Γ is a contour enclosing the segment $(-1, +1)$. Then the extremum is found to the root of largest modulus of the equation in λ.

$$\begin{vmatrix} B_{00}-\lambda, & B_{10}, & \ldots B_{s,0} \\ B_1, & B_{11}-\lambda, & \ldots B_{s-1,1} \\ \cdots & \cdots & \cdots \\ \cdots & \cdots & \cdots \\ B_{0,s} & 0\quad 0 & \ldots -\lambda \end{vmatrix} = 0$$

Various particular formulæ also are evaluated.

K. V. I.

* * *

Discovery of a New Element.—The element whose atomic number is 87 and which should be one of the alkalis had eluded the search of numerous investigators till to-day. Now H. Hulubei has found evidence indicating its presence in a cæsium mineral (*Comptes Rendus*, 1936, **202**, p. 1927). He made a systematic examination of the X-ray spectra produced by a number of minerals containing mixtures of the alkali elements. A Cauchois type of X-ray spectrograph was used giving a dispersion of 5 X.U. per mm. The K-lines were not made the basis of investigation since the K-lines of the elements neighbouring the one sought for are not well known. The approximate position of the characteristic X-rays

due to the unknown element was calculated by Moseley's rule. The L-spectrum of a number of minerals containing cæsium was carefully examined. The mineral pollucite gave two lines 1032 X.U. and 1043 X.U. in the expected position. These lines were concluded to be the $L\alpha$ lines of element no. 87. The possibility that the 1032 X.U. line may be $L\beta_3$ of Hg (1031·4 X.U.) was eliminated by the absence of the stronger $L\beta_1$ line and by the persistence of 1032 even when an oil diffusion pump was substituted for the mercury pump. The doubt that it may be $L\gamma_6$ or $L\gamma_2$ of Re was similarly removed. The line is not due to Tungsten since the L-lines of the latter are present, faint but distinct from 1032. Besides, this line and 1043 continue even when $L\gamma_3$ of Tungsten disappears. This same fact excludes the possibility of the line 1043 being either of the forbidden lines $L_I N_V$(1043·5) or $L_I N_{IV}$(1044·4) of Tungsten. The presence of other weak lines, which after eliminating some possible conicidences, may be identified as the $L\beta$ and $L\gamma$ lines of the new element confirms the conclusion that element 87 is contained in small traces in the mineral pollucite. The name Moldavium is proposed for the new element by its discoverer. The present success, in spite of the failure of previous workers, is explained by the fact that present-day X-ray technique allows the detection of an element which forms but one part in 10^7 of a mixture.

T. S. S.

Influence of Ultrasonic Waves on Gels.—The mechanism of the liquefaction of thixotropic gels and peptising effect in general by ultrasonic waves has been studied by H. Freundlich and co-workers (*Trans. Faraday Soc.*, 1936, 32, 966). Liquefaction starts at the gel-air interface which has been strikingly demonstrated by the creaming up of air bubbles in the transparent thixotropic gels of aluminium oxide on irradiation by ultrasonic waves. The mechanism is one of formation and collapse of cavities, since no liquefaction takes place, in vacuum or under high external pressure when collapse or formation respectively of cavities cannot occur. Gelatin in water, glue and rubber in different organic liquids were completely peptised after about 40 to 60 seconds of irradiation while there was no peptisation in vacuum or under pressure. In addition to the vigorous movement to be seen in the two phase systems when irradiated and the heat developed, cavitation also may play an important rôle in the peptisation of gels.

K. S. RAO.

Determination of Gallium in Aluminium.—J. A. Scherrer (*J. Research Natural Bureau of Standards*, 1935, 15, 585) describes two procedures for the determination of gallium in aluminum which are in outline as follows:

(*a*) Joint separation of gallium, vanadium, titanium, zirconium, iron, tin and copper by precipitation with cupferron, purification of the precipitate by removal of tin, copper and iron by means of hydrogen sulphide and recovery of all the gallium, vanadium, titanium and zirconium as oxides. This oxide-mixture is then analysed for the titanium, vanadium and zirconium present therein and the gallium obtained by difference.

(*b*) Direct determination by extraction with ether. A hydrochloric acid solution of the mixed oxides is shaken up with ether when all the gallium passes into the ether layer and all the aluminium remains in the acid solution. The ether extract is then suitably treated to enable the precipitation of gallium in a pure state by means of cupferron.

K. R. K.

BIOLOGICAL SCIENCES.

The Response of Crops to Varying Amounts of Water-Soluble Phosphates in Different Soils.—The poor condition of the vegetation on certain pastures deficient in soil phosphates which leads to the condition called "sweeny" or phosphate deficiency in animals grazing thereon has been the subject of study in its fundamental aspects by O. C. Bryan and W. M. Neal (*Jour. Agri. Res.*, 52, No. 6). Varying amounts of superphosphates (0 to 8,000 lbs. per acre) were added to Norfolk sand, Norfolk fine sand, and Orangeburg fine sandy loam in pot cultures and mustard, vetch and sorghum were used as test plants. It was found that the plants did not respond to a concentration of water-soluble phosphorus greater than 2 parts per million which was equivalent to 1,000 lbs. to 1500 lbs., and 8,000 lbs. of superphosphate per acre in the above three classes of soils respectively. The water-soluble phosphorus in the soil extracts differed greatly as between the soils; with the largest of the above doses, *viz.*, 8,0 0 lbs. per acre, the sand contained 17·2, the fine sand 10·3 and the loam only 1·9 parts per million. The greatest response was on the loam, the fine sand responded less and the sand least. A concentration of 0·5 part per million was necessary to secure appreciable growth of sorghum. The phosphorus content of the plants was proportional to the water-soluble phosphorus content of the soil. Because of the high fixing power of the loamy soil for phosphorus, larger applications of the element were necessary for maximum results.

A. K. Y.

Origin of New Epidermal Cells in the Skin of Frogs.—After the first week of larval life, the increase of epidermal cells in the skin of frogs is enormous but the number of mitoses are not many, pointing to the conclusion that the origin of the cells should be looked for in another source. J. A. Cameron (*Journ. Morph.*, June 1936, 59, No. 2) has determined that the cells of the deeper layers, of mesodermal origin, travel vertically upwards through the dermis and come to lie in the epidermis. This mesodermal origin and subsequent migration of cells which eventually become the epidermal cells of the skin is noticed in the skin of both normal and X-rayed tadpoles, where very few mitotic figures are observed in the epidermis suggesting the deeper mesoderm as the possible source of fresh epidermal cells.

The Morphology of a Nudibranch, *Kalinga*.—In order to furnish a morphological account of a tropical holohepatic nudibranch mollusc, K. V. Rao (*Rec. Ind. Mus.*, March 1936, 38, Pt. 1), has studied the anatomy in detail, of the widely distributed *Kalinga ornata*. In describing the alimentary system, reference is made to the radula, its formula and its movement. The

peculiar histological structure of the hepatic ducts is noted and it is also said that the intestine is the chief absorptive organ. The auricle and the ventricle are free from endothelial lining and it is said that the heart muscles are bathed in blood. The excretory and nervous systems are normally disposed. The ovotestis is recorded to generate sperms first and then the female cells.

The Investigation of the Cleavages in Granites.—In connection with his work on the Bavarian forest granites J. F. Bell (*Eco. Geology*, **31**, No. 3) has suggested an interesting line of work on the interrelationship of fabric and cleavage in granites. From a long time, cleavage has been attributed to such causes as various factors influencing the consolidation of the liquid magma, pressure, arrangement of minerals like felspar and quartz, etc. By following the petrofabric analyses of Sander and Schmidt by using an universal stage, Bell has now concluded that the arrangement of the biotite mica is mainly responsible for the development of joints and cleavages. He has further shown that by this method of investigation, the crushing strength of the granites can also be estimated.

SCIENCE NOTES.

Weight of a Drop as a Function of the Diameter and Material of an Orifice.—Mr. D. L. Das, Lecturer in Physics, Cotton College, Gauhati, writes:

The weight of a drop for an orifice is found to be very nearly the same, when the period of dropping is about ten seconds or more (A. Adler, *Science Abstracts*, Dec. 1935, No. 4896). Experiments were conducted with eight orifices,—four of brass and four of iron—the period of dropping being about 15 seconds. Short uniform tubes of different internal diameters were taken and each tube was bevelled from outside, to a circular knife edge, at one end. Water was allowed to pass from a reservoir through a fine capillary tube and then drop from the orifice, horizontally held. The period of dropping was adjusted by changing the height between the orifice and the constant level of water in the reservoir. The results obtained are given in the table below:—

Orifice material	Orifice diameter (in cms.)	Temperature of water (in °C.)	Period of dropping (in sec.)	Average mass per drop (in gms.)	$\frac{\textit{Drop mass}}{\text{orifice diameter}}$
Brass	0·680	25·7	15·2	0·0966	0·1421
,,	0·620	25·8	15·7	0·0871	0·1405
,,	0·552	25·9	14·9	0·0785	0·1422
,,	0·431	25·9	15·6	0·0654	0·1517
Iron	0·640	25·9	15·3	0·0940	0·1469
,,	0·602	25·8	15·2	0·0879	0·1460
,,	0·492	25·7	14·8	0·0747	0·1518
,,	0·410	25·6	15·0	0·0650	0·1585

The sixth column of the table shows that the ratio of the mass of a drop to the orifice diameter in the case of either material is not a constant, but it slowly decreases and then increases as the diameter decreases within the range of the orifice diameters used. If the masses of drops be plotted against the corresponding orifice diameters in a graph, two separate but nearly parallel curves will be obtained for iron and brass orifices respectively. From the graph it can be shown that if two orifices are used one of brass and the other of iron but both of the same diameter the mass of a drop from an iron orifice is about 1·04 times greater than that from a brass one, for the same rate of dropping and at the same temperature. Thus from a measure of the weight of drop, a relative idea of the surface tensions for different materials can be obtained; the surface tension between iron and water is about 1·04 times that between water and brass.

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Birthday Honours.—The names of the following men of science have been included in the list of the recipients of Birthday Honours:—*Knighthood*: Major-General C. A. Sprawson, Director-General, Indian Medical Service. *C.I.E.*: Dr. F. J. F. Shaw, Director, Imperial Institute of Agricultural Research; *O. B. E.*: Ghulam Yazdani, Director of Archæology, Hyderabad, Deccan; *M.B.E.*: Mr. S. Rajagopal Nayudu Garu, Ag. Chemical Examiner, Madras; *Rai Bahadur*: Mr. B. M. Das, Superintendent, Bengal Tanning Institute; Mr. T. N. Banerji, Professor of Medicine, Medical College, Patna; Mr. S. N. Mukarji, Reader in Mathematics, Delhi University; *Rao Bahadur*: Mr. S. Ramakrishnan; Avl., Professor of Bacteriology, Medical College, Madras; Mr. K. N. Dikshit, Deputy Director of Archaeology; *Rao Sahib*: Mr. D. V. Bal, Agricultural Chemist, C. P.; Mr. K. I. Thadani, Botanist, Sind Agricultural Station, Sakrand.

* * *

A Terracotta Toy-Cart in the Indian Museum.—At the ordinary meeting of the Royal Asiatic Society, held on the 6th July, Mr. N. G. Majumdar exhibited a terracotta toy-cart. This unique specimen has been in the Museum for many years. Its findspot is unknown. The cart has six passengers represented in relief including two women, who are all in festive mood and enjoying themselves. The party is engaged in eating and music, as may be seen from a tray containing eatables, a *tabla* and a harp. A similar example of a toy-cart has recently been discovered at Kosam in Allahabad District, and it is very likely that this one also came from the same place. On artistic grounds it may be placed in the Sunga period (about 150 B.C.).

At the same meeting of the Society, Mr. S. K. Chatterji exhibited a set of old Oriya Playing Cards, made of cloth stiffened with a ground made of gum. They are circular in shape and are 2½" in diameter. Mr. N. Barwell communicated a paper entitled "Influence of Oriental *Motifs* upon book-bindings in Europe from the 15th to the 18th century".

Maulavi Muhammad Sanuwar Bakht was ballotted for as an ordinary member.

Excavations at Nalanda.—Among the new buildings which have been exposed at Nalanda is a monastery where about 200 metal images and an image with bronze head and agate body have been found. According to Dr. K. P. Jayaswal, President of the Managing Committee, Patna Museum, this monastery was evidently inhabited by monk-artists, as materials for fashioning images have been found in the rooms. Some of the images are of great artistic value.

The system of disposal of the dead in the ancient university has been brought to light by recent excavations. The dead were cremated in a straight row and the ashes were left undisturbed. Many of the smaller *stupas* which were formerly regarded as merely ornamental, had proved to be relic memorials where bones and hair of the deceased saints were placed under double sealings, which in their turn were preserved in clay caskets.

The finds recovered from the excavations at Rajgir in the Maniyar Matha area, specially the terra-cotta with various spouts which are at present housed in the Nalanda Museum, are, according to Dr. Jayaswal, of exceptional importance and such antiquities have so far not been reported anywhere in the world. The Nalanda museum which will soon be extended, will be one of the most important museums of the world, when all the exhibits excavated are arranged and housed properly.

* * *

De Havilland Arch of Seringapatam.—This famous swinging arch, one of the chief attractions of the tourists and a marvel of bridge engineering which was a protected monument, collapsed on 2nd July. The Director of Archæology in Mysore, who visited the scene, considers the restoration of the arch impossible. The Government are considering how best to preserve the remains.

The Arch was built 125 years ago by De Havilland, a French Engineer, attached to the Seringapatam garrison during Tippu Sultan's reign. De Havilland was asked to build a bridge across the Cauvery to facilitate the march of troops and civilian population. Before launching on the scheme to project a bridge without piers and columns, he undertook to construct a specimen bridge in the island. The result was a brick arch with a span of 112 feet, greater than any attempted at that time. This monument of his skill, which withstood all weathers for over a century and a quarter, has been lost for ever.

* * *

The Woodhouse Memorial Prize for 1935 has been awarded to Dr. Mohammad Aziz, D.Sc. (Agric.), of the Wheat Breeding Sub-Station and Rust Research Laboratory, Simla, for his essay on "Problem of Wheat Rusts in India".

* * *

The Sir Vincent Massey Scholarship for the year 1936–37 has been awarded to Mr. R. C. Lacy, M.Sc. of the Allahabad University for study and research in Plant Pathology.

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Dr. S. K. Banerji officiates as Director-General of Observatories *vice* Dr. C. W. B. Normand, granted leave for three months and two days with effect from July 11 or date of availing.

Dr. C. S. Fox will officiate as Director of Geological Survey of India *vice* Dr. A. M. Heron, granted four months leave from India with effect from July 30.

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Problems of Broadcasting in India.—*The Indian Listener* (June 22) has published a very timely article dealing with the principal problems confronting the development of broadcasting in India. It is an appeal addressed to scientists all over India to co-operate with the Research Department of the Broadcasting Service in determining the nature of the major factors.

To make a success of Broadcasting in India, where an enormous area has to be covered with a dependable signal which will be sufficiently higher than the interfering atmospherics, several technical problems demand close investigation. Both scientific and lay opinion agree that *atmospherics* constitute the first problem. The data available on this point are very incomplete and little work seems to have been done on the distribution of atmospherics on the frequency spectrum. What is wanted is a series of observations of the absolute strength of atmospheric noise at different frquencies. Diurnal and seasonal variations have also to be observed and data tabulated before we can predict with any degree of certainty the probable service area of a station or decide upon the optimum band of frequencies. In order to be able to co-ordinate the results obtained, it is advisable to employ similar methods at all the observing stations. It is suggested that measurements be made immediately after 7–0, 10–0, 13–0, 16–0, 19–0, and 22–0 hours and in each case observations be recorded of the field strength of atmospheric disturbances alone in microvolts per meter, the values being interpreted over 5-minute period on each spot frequency. The variations should be recorded on the complete spectrum between 150 and 20,000 kilohertz.

The collection of data on atmospheric disturbances will be helpful in ascertaining suitable frequencies for transmission. Short-wave experimental transmissions will be made from Delhi, as soon as funds become available for erection of a transmitter, at a number of frequencies, and the results observed. In this connection it is hoped to obtain the help of the listening public as well as the scientific world. The former will be requested to submit reception reports, while scientific workers at different distances from Delhi will be requested to make field strength observations. In this way it will be possible to obtain extensive correlatory curves which will be helpful in founding a short-wave service.

As the suitability of high frequencies for local broadcasting has yet to be proved, the medium frequency band is at present the main vehicle for the diffusion of broadcast programmes. One of the chief difficulties in the drawing up of a suitable scheme of development in this line is the paucity of data on earth conductivity. Since ground-ray attenuation is a function of both frequency and ground conductivity, it is necessary to have reliable data on soil characteristics, over varying types of terrain. It is very desirable, therefore, to have a series of measurements taken at different parts of India over ground ranging from granite and gneiss formations to the pastoral

deltaic areas. This work will be undertaken by the Research Department but co-operation from outside will be very helpful.

* * *

Expeditions to Himalayas.—A Japanese expedition to negotiate the Mount Nandakot in the Himalayas is expected to start the ascent from Spetember 1. This expedition is supported and financed by the Rikkyo (Missionery University) and *Nichi* an influencial daily of Tokyo. This is considered to be of the nature of a trial for a projected expedition to Mount Everest. The party consists of eight members five of whom are graduates. Their previous experiences comprise the conquests of Mount Aliga in Switzerland and Alberta Peak in Canada.

Another expedition to Mount Nanda Devi, consisting of four Americans and four Englishmen planned by the Harward Mountaineering Club and the British America Himalayan Expedition, has already started making preliminary arrangements. Their base camp will be established at a height of 14,000 feet, and the actual ascent from the camp will start either by the end of August or the beginning of September. The expeditionists, all of whom possess considerable mountaineering experience, are equipped with light wind-proof clothing, shoes suitable for deep snow climbing and dried provisions, and they hope to reach the summit of Nanda Devi before the 20th September.

* * *

International Conference on Timber Utilisation, London.—The Second International Congress, organised by the Comité International du Bois', Department for Timber Utilisation in conjunction with its member organisation, the Timber Development Association, Ltd., was held in London from 31st March to 3rd April. 21 countries were represented at the Conference, which was inaugurated by the Earl of Dunmore. Three public sessions were held: (1) Forestry and Timber Utilisation, (2) Timber Research and Timber Utilisation, and (3) The Utilisation of wood waste.

The intimate collaboration in all matters concerning the wide utilisation of timber has already shown very satisfactory results. The various papers read at the Conference served to emphasise the similarity of problems concerning timber in various countries. A main Committee was appointed to receive the reports on the activities of various national organisations for timber utilisation.

It was resolved in principle (1) to continue and intensify international collaboration, (2) to arrange international inquiries, and (3) to organise international competitions. It was considered that all countries represented at the Conference should participate in one pavilion at the World Exhibition to be held in Paris in 1937.

The delegates visited the Prince Risborough Forest Products Research Laboratory, the well-equipped centre of English timber research.

* * *

Inventive Activities in India.—The annual report of the Patent Office reveals a decrease of about 25 per cent. in the number of applications for patents originating from India as compared with those for the year 1934.

While a decrease was noticed in the patents connected with electrical industry, those concerning chemical industry show a marked increase. The subjects investigated cover a wide range such as synthetic resins, drugs, wetting agents for textile processing, investigations on sterols, the manufacture of sulphuric acid by contact process and manufacture of salts by base-exchange reactions. There was a notable increase in patents for surgical and medical appliances. Applications for patents concerning inventions in rail and road transport and aeronautics constituted ten per cent. of the total. Steady progress was maintained with respect to inventions relating to agriculture and allied industries. A number of applications relating to guttapercha and India rubber was received. In the field of glass manufacture, the investigations were mainly directed towards the production of non-shatterable safety glasses, glass suitable for use as a protective coating or glaze upon the interior surface of sodium lamp bulbs where the glass is exposed to highly heated sodium vapour, and the manufacture of certain kinds of boro-silicate glass which are moisture resistant and highly inert to hot sodium vapour and also more transparent than glasses hitherto used for the purpose.

* * *

An Indian System of Physical Culture.—Maharaja Balasahib Pant Pratinidhi, Ruler of Aundh State, a keen follower, an ardent advocate and enthusiastic propagandist of *Surya Namaskar*, an ancient system of Physical Culture adopted for individuals and groups and suitable for all ages and both the sexes, is now touring in Europe to popularise this system. The Ruler of Aundh has made the system compulsory in all the schools of his State and having satisfied himself with the results obtained, he is now advocating the system not only to the peoples of India but also to those outside. The system affords excellent movement to the three vital parts of the body—the abdomen, the chest and the spinal cord. By reviving this excellent system and spreading it, the Maharja has done a lasting service to the cause of Physical Culture. He is the author of a book dealing with the system, originally written in English but now available in many Indian languages.

* * *

The Imperial Institute of Sugar Technology.—The Imperial Institute, which is housed in the Harcourt Butler Technological Institute, was formally brought into being on the 1st July. Mr. R. C. Srivastava, Sugar Technologist in the Imperial Council of Agricultural Research, is the first Director of the Institute. The Teaching and Research Staff consists of about 20 members including three Professors of Sugar Technology, Sugar Engineering and Sugar Chemistry, each assisted by an Assistant Professor, Research Physical Chemist and Biochemist.

The Central Government's contribution to the Institute will be about Rs. 14 lakhs spread over a period of 5 years, which with grants of Rs. 25 lakhs made to the Imperial Council of Agricultural Research for the promotion of sugar research, brings the total Government contribution to Rs. 39 lakhs.

At the recent conference held at Simla to review the progress of sugar research, it was decided to recommend the continuation of the two schemes which have reached the end of their five-year periods, *viz.*, the Deccan Sugarcane Research

Station at Padegoan where considerable work on sugarcane physiology has been carried out, and the scheme dealing with sugarcane diseases carried out at the Imperial Institute of Agricultural Research at Pusa.

* * *

Imperial Council of Agricultural Research.—Sir John Russel. Director of the Rothamsted Experimental Station, and Dr. N. C. Wright have been appointed to conduct the scientific survey of the working of the Imperial Council of Agricultural Research since its inception. Mr. Sethi. Rice and Sugarcane Expert at Shahajahanpur and Prof. Agarwal, of the Lahore Veterinary College, have been appointed as Indian Secretary and Adviser respectively to the Experts, who, it is understood, will arrive in India in November. Their headquarters will be Delhi but will visit a number of research stations in several provinces during their six months' stay in India.

* * *

Properties and Applications of "Everdur".—An alloy of copper, silicon and manganese, whose remarkable properties have procured for it a wide application during the past 10 years, is now available as a British product, following the acquisition by I. C. I. Metals, Ltd., of the manufacturing and selling rights in the United Kingdom. The material is now produced in the form of plate, sheet, strip, tape, rod and wire over a wide range of sizes and tempers to suit individual requirements as well as in ingots for casting. Properties, applications and methods of working are fully described in an illustrated booklet recently issued by the company.

"Everdur" is the first commercial application of copper containing substantial amounts of silicon, and marks a decided advance in the metallurgy of copper alloys in that it combines the tensile strength of medium and low carbon steel with the non-rusting and corrosion-resisting properties of copper. The wide range of its potential applications may be judged from such other desirable properties as a high fatigue limit and good machinability, and from the fact that it is non-magnetic, easy to cast or to work hot or cold, and readily weldable by all commonly used methods. These properties should make possible the replacement of steel with "Everdur" in many applications involving corrosive conditions.—(*Chemical Age*. 1936, 34, *Metal. Sect.*, p. 36.)

* * *

A Review of the Physiology and Biochemistry of the Sulphur Bacteria.—(His Majesty's Stationery Office. Price 9*d*. net., post free 10*d*.) The importance of sulphur in inorganic nature has long been known but the recognition of the biological significance of sulphur came later. There is, in fact, "a sulphur cycle" which is an expression of the manner in which sulphur passes from inorganic to organic nature and *vice versa*. This circulation is largely due to the sulphur bacteria whose activities are dealt with in this review where reference is made to their economic importance and to the problems concerning them that remain to be solved. One of the major problems is to utilise them commercially, for, up to the present, it is their harmful rather than their beneficial effects that have attracted attention.

* * *

Survey of the Biochemical Activities of the Acetic Acid Bacteria.—His Majesty's Stationery Office. Price 1*s*. net. post free 1*s*. 1*d*.) It is just 100 years since the conversion of wi[ne into] vinegar or acetic acid was definitely decl[ared to] be caused by living organisms which a[t first] were thought to be of one species. Late[r work] has shown that there are many specie[s of] acetic acid bacteria, and in recent years a[n] attempt has been made commercially to [utilise] their powers other than in the vinegar ind[ustry].

This survey gives a comprehensive acco[unt of] the nature and variety of the chemical trans[forma]tions which this group of bacteria are a[ble to] effect. Suggestions are made for their a[pplica]tion to the production of certain comp[ounds] which are difficult to obtain by ordinary ch[emical] methods and for the investigation of proble[ms of] potential utility.

* * *

Announcement

Paris International Exhibition, 1937. International Exhibition with the support o[f the] French Government will be held in Pari[s in] April, 1937.

The exhibition will be divided into four[teen] sections which will again be sub-divided into sub-sections. The subjects to which the differ[ent] sections will be devoted are: Expression [of] thought—Literary, musical and artistic, includin[g] the scientific discoveries in their application; social questions including co-operation, hygiene, organisation of intellectual and manual labour; arts and crafts including higher education, artistic and technical diffusion including radi[o-tele]phony, television and cinematography; urban [art] including town-building, horticulture and agri[]culture; graphic and plastic arts; buil[ding] industry; interior decoration and furnitu[re;] work of art including jewellery, morocco leat[her] work, scientific and musical instruments, bo[oks] and reviews printing; apparel including dr[ess] materials and perfumery; transport and tour[ism] including hotels and travelling requisites; co[n]gress, processions and sports; publicity includi[ng] shop windows and display articles.

Further particulars can be obtained from Monsieur le Commissaire Général de l' Expos[i]tion Internationale, Paris 1937, Grand Pala[is] Porte C, *Paris*.

* * *

World Congress of Pre-Historic and Proto-Historic Science.—The second session of the Congress will be held in Oslo on August 3 to 9 this year, in accordance with the decision taken at the first session in London in 1932. The Norwegian Committee of Honour and the Organising Committee announce that they invite all pre-historians and other persons interested, to attend the Congress. Acceptance of this invitation should be sent to Bureau de Congress, Universities Oldskassamling, Oslo. The Organising Committee is putting on agenda several of the more important problems which are occupying the attention of Scandinavian archaeologists and which are of international interest. These include excavations of sites dating from the Stone Age of Finmark which set many problems of general interest; rock carvings of the Arctic group to which the most modern research methods have been applied of late years; the remains of farms of the Migration period; the decorative art of the Migration period and finally the textile art of the Viking. Special exhibitions ...

been arranged so that members may gain first-hand experience of the subject. Excursions have been arranged to the old Vestfold during the Congress and to Stavenger, Bergen or Trondheim, after the close of the Congress.

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The League of Nations will award the Darling Prize of 1,000 Swiss francs this year for the best work in the pathology, etiology and prophylaxis of malaria. Works which have been published within the last five years as well as unpublished work may be submitted.

* * *

Indian Science Congress, 1937.—The 24th Annual Meeting of the Indian Science Congress will be held in Hyderabad (Deccan) from January 2 to 8, 1937. His Exalted Highness the Nizam of Hyderabad has consented to be the Patron of the meeting. Rao Bahadur T. S. Venkataraman of Coimbatore will be the President.

Papers submitted for reading at the session of the Congress can only be submitted by Ordinary and Full Session Members or through Ordinary Members. No papers are admissible for reading at the session by any one who has not been enrolled as a member by September 15, 1936.

Papers for the Congress should be forwarded together with three copies of an abstract to the President of the Section concerned not later than 15th September 1936. Abstracts are to be typewritten and must not exceed 200 words.

Dr. H. Hyder Ali Khan, Principal, Medical College, Osmania University, and Dr. Muzafferuddin Qureshi, Head of the Department of Chemistry, Osmania University, Hyderabad have been appointed Local Secretaries.

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We acknowledge with thanks the receipt of the following :—

"Actualités Scientifiques et Industrielles," Nos. 271, 277, 295, 296, 299, 300, 303, 312, 313, 325–327, 329, 333, 335–337, 345–347.

"The Agricultural Gazette of New South Wales," Vol. XLVII, Part 6, June 1936.

"Journal of Agricultural Research," Vol. 51, Nos. 5–7.

"Indian Journal of Agricultural Science," Vol. VI, Part II, April 1936.

"The Philippine Agriculturist," Vol. XXV, No. 1, June 1936.

"Journal of the Royal Society of Arts," Vol. LXXXIV, Nos. 4357–4360.

"The Biochemical Journal," Vol. 30, No. 5, May 1936.

"Journal of the Institute of Brewing," Vol. XLII, No. 6, June 1936.

"Chemical Age," Vol. XXXIV, Nos. 882–885.

"Journal of the Indian Chemical Society," Vol. 13, No. 4, April 1936.

"Berichte der Deutschen Chemischen Gesellschaft," Vol. 69, No. 6.

"The Russian Journal of General Chemistry," Vol. VI, Nos. 3 and 4.

"Experiment Station Record," Vol. 74, Nos. 4 and 5, April–May 1936.

"Transactions of the Faraday Society," Vol. XXXII, No. 6, June 1936.

"Indian Forest Records," Vol. I, No. 3 (Silviculture—The Distribution of Sesquioxides, Silica and Organic Matter in Forest Soil, etc.).

"Forschungen und Fortschritte," Vol. 12, Nos. 16 and 17.

"Genetics," Vol. 21, Nos. 1 and 2, Jan. and March 1936.

"Transactions of the Mining and Geological Institute of India," Vol. XXX, No. 3, April 36; Vol. XXXI, No. 1, June 1936.

"Government of India Publications :—

"Monthly Statistics of Production of Certain Selected Industries of India (Department of Commercial Intelligence and Statistics), No. 12 of 1935–36, March 1936."

"Indian Trade Journal," Vol. CXXI, Nos. 1563–1566; Vol. CXXII, No. 1567.

Irrigation Research Institute, Punjab, Vol. II, No. 11; No. 12; Vol. V, Nos. 4 and 5.

Publications of University of Illinois :—

No. 34.—"An Investigation of the Durability of Molding Sands". No. 36—"The Cause and Prevention of Steam Turbine Blade Deposits."

"The Calcutta Medical Journal," Vol. 30, No. 12, June 1936.

"Mathematics Student," Vol. III, No. 4, Dec. 1935.

"Review of Applied Mycology," Vol. 15, No. 5, May 1936.

"The Cambridge Bulletin," Vol. LXXVIII, June 1936.

"Memoirs of the India Meteorological Department," Vol. XXVI, Part V.—Soundings of Temperature and Humidity in the Field of a Tropical Cyclone and a Discussion of its Structure, by K. R. Ramanathan.

Imperial Bureau of Plant Genetics (for Crops other than Herbage):—"Plant Breedings Abstract, Supplement II.—Summary of Report received from Stations in the British Empire," 1932–35, April 1936.

"London Shellac Research Bureau (controlled by the Indian Lac Cess Committee, India), Technical Paper," No. 8.—"Darkening of Lac Solutions and the effect of Oxalic acid thereon," by Lal C. Verman, May 1936.

Do. No. 7.—"Fundamental Physical Properties of Lac, Part III. Electrical Properties" by Lal C. Verman, May 1936.

"Bulletin No. 2 of Indian Industrial Research—A Survey of the Indian Glass Industry," by E. Dixon.

"Nature," Vol. 137, Nos. 3473–3476.

"Journal of Nutrition," Vol. 11, No. 5.

"Indian Journal of Physics and Proceedings of the Indian Association for the Cultivation of Science," Vol. X (XIX), Part III.

"Canadian Journal of Research," Vol. 14, Nos. 4 & 5, Secs. A, B, C & D.

"Ceylon Journal of Science, Sec. E.—Meteorology," Vol. II, Part I.

"Scientific American," Vol. 154, No. 6, June 1936.

Catalogues

"Monthly list of Books on Natural History and Science," June 1936. (Messrs. Wheldon and Wesley, Ltd.).

"Mitteilungen über Neuerscheinungen und Fortsetzungen, 1936," Nummer 3, (Juni), (Messrs. Verlag von Gustav Fischer in Jena).

ACADEMIES AND SOCIETIES.

Indian Academy of Sciences:

June, 1936.—B. N. SASTRI AND M. SREENIVASAYA: *Lipins of Fenugreek* (Trigonella fœnum græcum).—The isolation and fractionation of some interesting lipins are described. S. PARTHASARATHY: *Ultrasonic Velocities in Organic Liquids. Part IV.—Halogen Compounds.*—A study of 15 compounds shows that the acoustic velocity is lowered on introduction of a heavier atom, and also by the presence of a double bond. N. KRYLOFF AND N. BOGOLIÜBOFF: *Upon Some New Results in the Domain of Non-Linear Mechanics.* R. ANANTHAKRISHNAN: *The Raman Spectra of Propylene and Iso-Butane.*—While the lines due to propylene are sharp and well polarised, many of those due to iso-butane are broad and highly depolarised. C. S. VENKATESWARAN: *The Raman Spectra of Selenious Acid and Its Sodium Salts.*—A study of the solid and aqueous and alcoholic solutions shows that the lines broaden out and undergo variations in frequency shift and intensity. It is postulated that the acid exists mainly in an unsymmetrical pseudo acid form in the solid and alcoholic solutions, while in aqueous solutions it is almost wholly converted into the symmetrical true acid form. The dissociation of the acid is weak. S. PARTHASARATHY: *Resonance Curves for a Quartz Oscillator Immersed in Liquids.*—A greater number of diffraction orders was observed, not at the resonance of the crystal but at a point of lower frequency, corresponding to the region of clear resolution of resonance curves. R. K. ASUNDI: *Rotational Analysis of the Ångström Bands at λλ 6080 and 6620 Å.U.* R. K. ASUNDI AND R. SAMUEL: *On the Dissociation Energy of Carbon Monoxide.* R. S. KRISHNAN: *Dispersion of Depolarisation of Rayleigh Scattering. Part I.—Fatty Acids.*—It is pointed out that the formation of large molecular groups in the fatty acids is probably responsible for the observed dispersion of depolarisation. V. S. RAJAGOPALAN: *On the Structure and Optical Characters of the Nacre in Irridescent Shells.—Part I.*—A microscopic study using plane polarised light and also convergent light supports the optical observations and X-ray studies made on the same. B. K. SINGH AND S. PRASAD. *The Physical Identity of Enantiomers. Part II.* (a) (*The Rotatory Dispersion of* d- l- *and* dl-*forms of Iso-nitrosocamphor and their sodium derivatives.* (b) *The Differences in the Physiological Action of* d- l- *and* dl- *forms of Sodioisonitrosocamphor.* S. PARTHASARATHY: *Diffraction of Light by Ultrasonic Waves—Part II. Reflection and Transmission Phenomena.*—It is made out that transmission (Raman-Nath's theory) and Reflection (Brillouin's theory) are two separate phenomena, superposed on each other, in the case of diffraction of light by high frequency sound waves. B. V. RAGHAVENDRA RAO: *Doppler Effect in Light Scattering in Liquids. Part III.—Polarisation of Light Transversely Scattered by Formic and Acetic Acids.*—The central undisplaced component shows an appreciable degree of depolarisations indicating presence of large clusters of molecule, in these liquids.

Indian Mathematical Society:

December 1935.—C. N. SRINIVASIENGAR: *On a Property of the Focal Surface.*—The paper deals with the exceptions to the theorem: Any surface of the congruence touches the focal surface at the foci of any of its curves. It is explained here that the surface generated by a singly infinite system of curves $F_r[x, y, z, a, \phi(a)] = 0$, $r = 1, 2$ can be guaranteed to touch the focal surface at the focal points of these curves only when the locus of the focal points is not an envelope of the curves. The case of exception is discussed, and some special types of congruences are considered. The following result is deduced from the discussions:

If any singly infinite system (except, in general, one particular system) of surfaces of the congruence possesses a unique (*i.e.*, non-degenerate or single) envelope, this envelope constitutes the focal surface or part of it. HANS RAJ GUPTA: *On Linear Quotient-Sequences.*—Let $\left[\frac{x}{y}\right]$ denote the quotient when a positive integer x is divided by a positive integer y. By a linear *quotient-sequence* is meant the set of numbers $\left[\frac{Kr+l}{m}\right]$, $r = 1, 2, 3, \ldots$; K and m being positive integers, and l any integer, provided that if l is negative, $|l| \leqslant K$. The following problem is discussed:

Given a set of n positive integral numbers $a_1, a_2, \ldots, a_n$ such that $a_r - a_{r-1} = d$ or $d+1$, to express, if possible, the given set as a linear quotient-sequence modulo m, where $m \leqslant n$. N. DURAI RAJAN: *Foci in Complex Geometry.*—A discussion of the properties of foci of a curve of class $n-1$ touching all the mutual joins of n points. M. ZIAUDDIN: *Recurrence Formulæ for Bernoulli's Numbers.*—Some new recurrence formulæ for the Bernoullian numbers are investigated with the aid of Symmetric Functions and Determinants. S. S. PILLAI: *On the Nature of the Contact of the Conics* $S = 0$ and $S + \lambda T = 0$: If $S \equiv F(x, y) = 0$, $T \equiv (x - x_1)\frac{\partial F}{\partial x_1} + (y - y_1)\frac{\partial F}{\partial y_1}$ where $F(x_1, y_1) = 0$, it is proved that the curves $S = 0$ and $S + \lambda T = 0$ touch at (x_1, y_1) internally or externally according as $\lambda < 1$ or $\lambda > 1$.

March 1936.—V. GANAPATHY IYER: *On Integral Functions of Order One and of Finite Type.*—Let $f(z)$ be an intergral function of order one. Let $0 < \lambda_1 < \lambda_2 < \ldots < \lambda_n \ldots$ be a sequence of numbers tending to infinity. Let $\phi(z) = \prod_1^\infty\left(1 - \frac{z^2}{\lambda_n^2}\right)$, and $f(\lambda_n) = y_n$, $f(-\lambda_n) = y_{-n}$, the sequence $[y_{\pm n}]$ being bounded. Then under suitable hypothesis on $[\lambda_n]$, the following theorems are established by the help of certain lemmas proved in the course of the paper.

THEOREM 1. Let $[y_n]$ in addition to being bounded, satisfy one of the following conditions:

(a) the real parts of $\frac{y_n + y_{-n}}{\phi'(\lambda_n)}$ and $\frac{y_n - y_{-n}}{\phi'(\lambda_n)}$ do not change sign as n varies, not all these real parts vanishing; (b) the imaginary parts of these expressions do not change sign as n varies, not all these imaginary parts vanishing.

Under one of these conditions, the type of $f(z)$ cannot be less than $l(\phi)$, the lower type of the base function $\phi(z)$. If $M(r)$ and P be the maximum of $|f(z)|$ on $|z| = r$, and the order of $f(z)$, the lower type l is defined as $\underset{r \to \infty}{\text{Lim}} \frac{\log M(r)}{r^{\rho}}$.

THEOREM 2. Let (a_ν), $\nu = 1, 2, \ldots$ be a sequence of numbers such that $|a_\nu| \to \infty$ as $\nu \to \infty$. Let $E(\lambda, a)$ denote the set of points $z = \pm a_\nu \lambda_n$, $n = 1, 2, \ldots$ Let $f(z)$ be a function of order one and minimal type. Then it reduces to a constant if it is bounded at the set of points $E(\lambda, a)$. R. C. BOSE: *Two Theorems on the Convex Oval.*—The following theorems are established:

(A) The tangents to a convex oval at the cylcic points cannot all touch the same circle.

(B) All the sextatic points on a convex oval cannot lie on the same conic.

Reciprocating the latter, the tangents to the oval at the sextactic points cannot all touch the same conic. S. S. PILLAI: *On Waring's Problem.*—Let $g(n)$ denote the least value of s required to represent every positive integer as the sum of s non-negative nth powers. Let $l = [(\frac{3}{2})^n]$ and $j = [(\frac{4}{3})^n]$ where $[x]$ denotes the integral part of x. The following results are established—

(a) If $n \geqslant 30$ and $[(\frac{3}{2})^n] \leqslant 1 - \frac{l+3}{2^n}$, (1) then $g(n) = 2^n + l - 2$, where (x) = fractional part of x.

(b) If $[(\frac{3}{2})^n] \geqslant 1 - \frac{l}{2^n}$, then $g(n) \geqslant 2^n + l + j - 3$.

(c) $g(n) = 2^n + l + O\left(\frac{4}{3}\right)^n$

(d) When $8 \leqslant n \leqslant 100$, $g(n) = 2^n + l - 2$.

(e) If $K(x)$ denotes the number of n's less than x for which (1) is true, then

$$K(x) \geqslant \frac{\log\left(\frac{4}{3}\right)}{\log 3} x + O(1).$$

Indian Chemical Society:

April 1936.—SHRIDHAR SARVOTTAM JOSHI AND P. V. JAGANNATHA RAO: *Thermo-Ageing of Colloids. Part I.—Variation of Refractivity.* PANCHANAN NEOGI AND KANAI LAL MANDAL: *Experiments on Resolutions of Co-ordinated Inorganic Compounds into Optical Isomers.—Co-ordinated Cadmium Compounds with Racemic and Active Propylenediamine.* P. C. MITTER AND PHANINDRA NATH DUTT: *Condensation of 3- and 4-Nitrophthalic Anhydrides with Phenol and Anisole.* P. C. MITTER AND S. S. MAITRA: *Studies in the* iso-*Flavone Series.* J. K. CHOWDHURY AND T. P. BARDHAN: *Molecular Size of Cellulose from Different Sources, Part I.* SANT SINGH BEDI AND KARTAR SINGH NARANG: *Quinazolines—Part IV.* N. M. BASU AND T. R. MAITRA: *Investigation on the Effects of Humidity and High Temperature on the NH_2-content of Different Samples of Rice.* KARTAR SINGH NARANG, JNANENDRA NATH RAY AND THAKUR DAS SACHDEVA: *Quinoline Derivatives—Part IV.* RADHA RAMAN AGARWAL AND SIKHIBHUSHAN DUTT: *Chemical Examination of* Cuscuta reflexa, *Roxb, Part III.—The Constitution of the Oil from the Seeds.* DINES CHANDRA SEN: *Studies in the Cyclic Thioketones, Part I.—Synthesis of Non-Polymerised Thiocyclohexanone, Thiocyclopentanone and Their Derivatives.* S. S. BHATNAGAR, M. B. NEVGI AND R. L. SHARMA: *Diamagnetic Susceptibilities of Tin in Di- and Tetra-Valency States.*

Calcutta Mathematical Society:

July 12, 1936.—B. B. SEN: *Note on the Stability of a thin plate under edge thrust, buckling being resisted by a small force varying as the displacement.* M. DE DUFFAHEL: *A reduction formula for the functions of the second kind connected with the Polynomials of Applied Mathematics.* R. C. BOSE AND S. N. ROY: *On the four centroids of a closed convex surface.* M. GHOSH: *The theory of extensional vibration of a beam excited by the longitudinal impact at the fixed end, the other end being free.* N. G. SHABDE: *On Infinite integrals of Bessel's functions.* N. C. CHATTERJEE AND P. N. DAS GUPTA: *On the Irreducible invariant and covariant system of two qualernary Quadrics and two linear complexes.* S. GHOSH: *A note on the vibrations of a circular ring.* R. C. BOSE: *The theory of associated skew rectangular pentagons.* H. S. M. COXETER (CAMBRIDGE): *On Schlafli's generalisation of Napiers Pentagramma Mirificum.* (Communicated by PROF. F. LEVI.)

Meteorological Office Colloquium, Poona:

June 19, 1936.—Prof. K. S. Krishnan of the Indian Association for the Cultivation of Science, Calcutta, addressed the Colloquium on "The Approach to the Absolute Zero".

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

University of Bombay:

Royal Institute of Science.—Dr. T. S. Wheeler, Principal of the Institute, has gone on leave to England till the 26th August, 1936. Prof. G. R. Paranjpe, Head of the Physics Department, will officiate as Principal in addition to his own duties during the absence on leave of Dr. Wheeler.

Dr. N. R. Tawde has been appointed a member of the Editorial Sub-Committee in Physics of the *Bombay University Journal.*

Dr. R. C. Shah will supervise the research work in Organic Chemistry during Dr. Wheeler's absence and is to act as Managing Editor of the Physical Sciences issue of the *Bombay University Journal*, during the absence of Dr. D. D. Kanga on leave.

Dr. S. Parthasarathy, a past student of this Institute, has been awarded the D.Sc. degree of the Bombay University.

University of Calcutta :

The Senate of the University of Calcutta has adopted a very important scheme for affording facilities to students of the University by including military studies as a subject for examination. The scheme was prepared by a Committee appointed by the Senate for the purpose. Military studies will be an optional subject. There will be two examinations—Junior and Senior—and the course for each will cover two years. Each examination will consist of two parts—practical and theoretical. Certificates will be issued on the results of each examination.

University of Mysore:

The Colleges reopened on the 24th June, 1936, after the summer vacation.

Dr. E. P. Metcalfe, D.Sc., F.Inst.P., Vice-Chancellor, who had proceeded on leave, returned on the 29th June, 1936, and received charge of the office from Mr. N. S. Subba Rao, M.A., Bar-at-Law.

Mr. D. S. Puttanna, B.A., F.R.C.S., L.M., D.T.M., Surgeon, has been appointed to act as Principal, Medical College, Mysore, during the absence of Dr. J. F. Robinson, B.A., M.D., F.A.C.S., F.R.C.S. (E), on deputation to Europe.

Extension Weeks organised by the University Teachers' Association were held during the month at Mysore and Nanjangud.

University of Nagpur:

In recognition of the excellence of his work, the degree of the Doctorate of Science of the Edinburgh University has been conferred upon Prof. S. C. Dhar of Nagpur with commendation. His work on Mathieu and Automorphic functions is regarded as a valuable standard work.

Education Board:

The following have been nominated by the Governor-General in Council as members of the Central Advisory Board of Education.—Mr. V. S. Srinivasa Sastri, Vice-Chancellor, Annamalai University; Mr. A. G. Clow, Secretary, Government of India Industries and Labour Department; Lala Shriram, Millowner, Delhi; and Mr. S. A. Roberts of Messrs. Bird and Company, Calcutta.

Krishnakumari Ganesh Prasad Prize and Medal for 1938.

THE Council of the CALCUTTA MATHEMATICAL SOCIETY invites "Thesis" embodying the result of Original research or investigation in the following subject, for the Krishnakumari Ganesh Prasad Prize and Gold Medal for the year 1938.

"Lives and Works of the ten famous Hindu Mathematicians:—
(1) Aryabhata, (2) Varahamihir, (3) Bhaskara I, (4) Lalla, (5) Bramhagupta, (6) Sridhar, (7) Mahabir, (8) Sripati, (9) Bhaskara II, (10) Narayana."

The last day for submitting the thesis for the present award is 31st March 1938. Three copies of the thesis (type written) are to be submitted.

The competition is open to all nationals of the world without any distinction of race, caste or creed.

All communications are to be sent to the Secretary, Calcutta Mathematical Society, 92, Upper Circular Road, Calcutta.

820-36.—Printed at The Bangalore Press, Bangalore City, by G. Srinivasa Rao, Superintendent, and Published by B. N. Sastri, M.Sc., A.I.C., A.I.I.Sc., for the "Current Science" Board of Editors, Indian Institute of Science, Hebbal Post, Bangalore.

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Industrial Research Bureau.

THE Industrial Research Council—a revised short name replacing Advisory Council for Industrial Intelligence and Research—met in Calcutta on July 2 and 3, 1936, to review the work of the Industrial Research Bureau since the inaugural session of the Council at Simla on July 8 and 9, 1935. It is therefore appropriate to consider the functions of the Bureau, and the possibilities it offers towards industrial development of this country on scientific foundations.

When the Provincial Economic Conference met in 1934, the delegates voiced the need for a clearing house of industrial intelligence, to assemble and sift the developments occurring in this and other countries and to supply information, or advice, which might be sought by industrialists and by those in search of industrial openings. The Government of India promptly met this need by inaugurating the Industrial Research Council and the Industrial Research Bureau. The latter is a practising organisation attached to the Indian Stores Department, the Director and staff of the Bureau having been provided with suitable accommodation at the Alipore Test House.

The Industrial Research Council is an advisory body, including representatives of Central, Provincial and State Governments, with some non-official members; and has been constituted mainly with a view to (1) co-ordinating and (2) developing, industrial research. The various institutions and research laboratories throughout the peninsula have hitherto lacked contact, with consequent overlapping of effort; and it is hoped that in future some better utilisation of available resources may be compassed. Whilst the Central, Provincial and State Governments naturally retain complete liberty in determining the character and extent of the researches conducted in their own institutions and laboratories, the Government of India trust that if sound schemes of co-ordination can be devised by the Council these will commend themselves to the relevant Governments. As regards development of industrial research, the Council is expected to indicate directions in which this appears desirable, and the regions or institutions in which it may be prosecuted most conveniently. Useful service in this field can be rendered by the Council in

advising the various Governments of subjects on which they might profitably embark, and the Government of India have already followed advice given by the Council at its first session by conducting the work of the Industrial Research Bureau on the lines then suggested.

The second session of the Council, recently held in Calcutta, reviewed this work, and indicated consequent extensions. The subjects included paints, dry cells, glass, vegetable oils for internal combustion engines, and a comprehensive test programme dealing with lime, cement, sand and surki based on the British Standards Institute test programme of 1932 for mortar and concrete. On all these topics a considerable amount of information has now been assembled, and the foundations laid for progressive research when the additional staff and equipment can be fully utilised. Meanwhile the Bureau has produced a most valuable *Bibliography of Industrial Publications* appearing in India from 1921 (pp. 257; Government of India Press, Simla; Rs. 4–6–0). This forms the first in a series of bulletins of Indian industrial research which the Council has authorised the Bureau to publish.

The second bulletin, entitled *A Survey of the Indian Glass Industry* (pp. 39; As. 14) by Mr. E. Dixon provides a broad conspectus of raw materials, fuel, methods of manufacture, types of furnace, costs and the general technology of this important industry, with a recognition of the difficulties under which it labours from foreign competition, particularly Japanese, from reckless internal competition and from lack of organisation, technical knowledge and modern methods of production. A promising outcome of this inquiry has been the design of a new furnace by Mr. Dixon intended, while economising fuel, to reach a higher temperature, thus diminishing the requisite quantity of soda-ash, and incidentally producing a form of glass more resistant to mechanical disturbance and climatic attack. When this new type of furnace was considered by the Council Mr. B. N. Mookerjee, a non-official member, generously offered to provide one-half the cost of its establishment, an offer which was gladly accepted. The Council also considered and authorised the cost of a field-survey of glass-making materials to be conducted by Dr. V. S. Dubey, Professor of Economic Geology in the Benares Hindu University.

At its first session in July, 1935, the Council appointed an Oils and Soap Committee comprising the industrial chemist of each province or State concerned, one officer from the Bureau and one from the Test House, along with official, or non-official experts nominated by the first-named representatives. Thus a strong body of eighteen members was assembled, charged with (1) surveying research already conducted and in progress, on fatty oils, soaps and essential oils; and (2) advising on co-ordination of this research and allocation of future work to suitable centres. The Committee met in Calcutta during November, 1935, and in Simla early last June; and submitted to the Council in July a voluminous and valuable report on their terms of reference. This is not the occasion for a detailed review of the report, but on a general survey the Council appreciated the opinion of the Committee that while the minor Indian vegetable oils have been extensively studied, more attention in future should be given to the major oil-seeds, namely, linseed, mustard and allied seeds, castor, til, groundnut, mohua, coconut and cotton. Emphasis was laid also on the importance of devising improved methods of refining, and eliminating the causes of rancidity. The Committee included in its report a useful schedule of subjects suitable for future research, embracing oils, soaps, glycerine-recovery and essential oils; and suggested an appropriate allocation of the connected problems to the various institutions and laboratories already equipped for their solution. Appendices to the report include a comprehensive bibliography, particulars of researches now proceeding in various laboratories, a schedule of equipment and staff available in these, a survey of the methods employed for crushing the major Indian oil-seeds, the disposal of sludge, and information relating to plants, herbs and roots now grown, or capable of being grown in this country as the source of essential oils.

Another subject before the Council and arising from action taken at the inaugural session was the award of prizes offered for improvements in an industrial process or appliance. The appointed Committee having specified proper conditions, these were advertised and met with a good response, the 57 papers received being then submitted to a sub-committee assisted by referees for adjudication. The twelve subjects recommended by the sub-committee for prize

were approved by the Council, and include the manufacture of photographic plates in India, a process for preparing pure alumina and sulphur dioxide from bauxite-gypsum systems, utilisation of nepheline syenite rocks, losses on electrical machinery due to open slots, electrolytic production of di-calcium phosphate from apatite, manufacture of santonin and utilisation of cashew-nut shell-oil. These are reasonably wide in scope and although nothing with outstanding utility has yet arisen the Council considered that the prize-offer experiment merits further trial.

The Calcutta session of the Council at which the foregoing matters were considered was opened by the Hon'ble Sir Frank Noyce who expressed satisfaction with the work already accomplished since the inaugural session a year ago; but could not hold out a prospect that the Government of India would be able in the present circumstances to do much beyond carrying the organisation and furthering the researches conducted by the Bureau. The Hon'ble Mr. A. G. Clow presided and at the conclusion of business the Council inspected the equipment provided for the Bureau at the Alipore Test House, where the work now in progress was explained by the Director of the Bureau, Mr. N. Brodie. The Government of India have taken a wise and hopeful step in the direction of co-ordinating Indian industrial research, and encouraging its fruitful development.

M. O. F.

The Himalayan Uplift since the Advent of Man: Its Culthistorical Significance.

By B. Sahni, SC.D., F.G.S., F.A.S.B., F.R.S.,
Professor of Botany, University of Lucknow.

IN this age of specialisation, which inevitably tends to confine thought in compartments, one is apt to overlook or to underrate the bearings of one branch of science upon another. A palæobotanist or a geologist, accustomed to think of Time in millions of years, stumbles upon an archæological discovery which at once brings him down to the human epoch. It forces his attention to the wanderings of man since the time he began to leave signs of his handiwork in the form of stone or metal implements, inscriptions, coins, seals or other monuments of his ever-increasing intelligence and power. The object of the present article is to draw attention to the significance of recent geological changes in northern India to the wanderings of prehistoric man.[1]

Among the most interesting scientific results of the Yale University North India Expedition,[2] led by the German geologist Dr. Hellmut de Terra, is the discovery, recently published, of Palæolithic stone-flake industries in three widely separated parts of northern India. The location of these sites of early human activity is of special interest from our present point of view. One was found by chance at Chitta, southwest of Rawalpindi, in the Potwar plateau; another, also accidentally discovered, was at Pampur, a few miles east of Srinagar, in the Kashmir valley; the third was at Kargil, just beyond the main Himalayan range, on the ancient trade route over the Zoji Pass connecting India with Central Asia, Tibet and China. A few years previously stone implements belonging to two distinct cultures, one Lower to Middle Palæolithic, the other Middle to Upper Palæolithic, had been discovered near Pindigheb,[3] in the Attock district, only about 10 miles from the Chitta locality (see foot-note 1).

These relics of the Old Stone Age, discovered at short intervals within the last few years, focus attention upon northern India as an area of unusual promise for our knowledge of early man. The special value

[1] A brief account of the physical conditions in Kashmir during this period, written from the point of view of the general reader, is given in the July number of this Journal, under the title: "The Karewas of Kashmir". The map in that article also illustrates the present paper.

[2] Hawkes, Hawkes and de Terra, "Palæolithic human industries in the N.W. Punjab and Kashmir and their geological significance," *Mem. Conn. Acad. Arts & Sci.*, 1934, 8, Art. I, i-iv, 1-15, six text-figs., two plates.

[3] *Loc. cit.*, p. 9. Another discovery of Palæolithic implements in the Potwar area, by Mr. D. N. Wadia, is mentioned below.

of these discoveries lies in the fact that at least some of the finds are stratigraphically datable, and therefore constitute a valuable link between the time-scales of the geologist on the one side and of the prehistoric archæologist on the other.

For details the reader must refer to the illustrated memoir by Hawkes, Hawkes and de Terra, published under the joint auspices of the Connecticut Academy of Arts and Science and of Yale University, and to the literature therein cited. Here a few extracts must suffice as a basis for discussion.

At Chitta, numerous flakes of indurated limestone, some of them of a material which must have been brought from a locality half-a-mile off, were found in a terrace overlying a lake deposit regarded as of early Pleistocene age. The geological evidence points to the implementiferous layer being of Middle Pleistocene age. At least four of the specimens are considered to be definitely due to human agency and have been assigned to the Lower Palæolithic. The conclusion is that this race of man flourished here during an interglacial phase or phases preceding the last major Pleistocene glaciation of northern India.

At Pampur, in a Mid-Pleistocene lake deposit of the Upper Karewa formation, Dr. de Terra found, among other relics, a broken flake of trap (volcanic) rock. This is also regarded as being undoubtedly an artifact, and as showing affinity with the Levallois stone-flake industry of Europe, which there stretched from Lower to Middle Palæolithic times. This specimen is said to belong to the same great family of flake industries as those found at Chitta; but being of more refined workmanship it may be of Middle rather than Lower Palæolithic age. Incidentally we may add that in an ancient soil cap covering this lake deposit, about nine feet below the surface, the remains of a very much younger culture were found, including ash and charcoal, with pottery and the clay figure of an ox. So far as I know, these have not yet been described, but their dating would obviously be of the greatest interest in view of recent speculations concerning the distribution of that archaic but highly developed Indian civilisation to which the probably unduly restricted name of the Indus civilisation has been applied.

The Kargil find was a solitary flake of trap, picked up on the surface of an old terrace. It must have originally belonged to the same family of industries as those recognised at Chitta and at Pampur, but was subsequently re-worked (probably in post-glacial times) into a square-ended scraper which might be of Upper Palæolithic or even of Neolithic date. Although not stratigraphically datable, this surface find "helps to confirm the presence of Palæolithic (and probably Lower Palæolithic) flake-industries in the N.W. Himalayan region".

Of the two industries recognised at Pindigheb we are here concerned mainly with the older, which is regarded as Lower to Middle Palæolithic and clearly related to that of Chitta, although a good deal more refined. In the opinion of the experts "neither the Pampur nor the Kargil flakes would be out of place in the Pindigheb find". Incidentally, some of the Pindigheb specimens indicate contact with the South Indian stone-core culture which thus seems to have extended its influence into northern India, although its original affinities are clearly with Africa.

Further observations of great interest in the present connection are made by Hawkes and Hawkes and de Terra on p. 10 of their memoir. They tend to the important conclusion that the flake implements from Chitta resemble those of Peking man (*Sinanthropus pekingensis*), who is regarded as an early member of the same group of human races as Neandertal or Mousterian man in Europe. We may sum up the entire evidence by saying that round about Middle Pleistocene time, when the main valley of Kashmir was still occupied by the great "Karewa Lake," interglacial man of about the same stage of cultural development as Neandertal or Mousterian man in Europe and as Peking man in the Far East, flourished (*a*) in the plains of the northern Punjab, (*b*) on the shores of the Karewa Lake in the heart of Kashmir and (*c*) just across the Great Himalayan range.

It is to this evidence of contact between early human cultures on the two sides of the main Himalayas and of the Pir Panjal range that I wish to draw the special attention of the reader.

The distribution of primitive man, like that of plants and animals, must always have been largely controlled by natural barriers, such as seas and high mountain chains. The close cultural contacts between India and China during the historic period are not difficult to explain. Not only do we

possess ample evidence of the sea-faring powers both of the Chinese and of our own people in ancient times, but Buddhist pilgrims have long been known for their hardiness as mountaineers. Palæolithic man, on the contrary, if one may say so without insult to his memory,[4] presumably had no incentives to travel beyond the hunt for the necessities of life. Although he may well have wandered between the Punjab and Kashmir by way of the Jhelum valley, it would be difficult, without special evidence, to explain his crossing even the Zoji-La (11,300 ft.) which is the lowest pass over the Himalayas. It is here that the significance of the recent work on the uplift of the Himalayas during the human epoch comes in. No one, so far as I know, has suggested that *migration across these mountains was possible in palæolithic times because the passes over them were then presumably not so high as to offer a serious obstacle to primitive man.*

On the contrary, Dr. de Terra regards it as "a surprising fact" that traces of a prehistoric human industry should have been discovered "even north of the Central Himalayan range on the border of Little Tibet". It is true that at the present moment we have no adequate idea of the extent to which the Himalayas have been uplifted since Kargil man existed. Not only is the exact date of the Kargil terraces still unknown, but the solitary implement from there was only a surface find; and the evidence of subsequent retouch which it shows further complicates the history of its provenance. But at the same time we have the expert opinion that "in its original form it may certainly be attributed to the great family of Palæolithic flake-industries" known also from Chitta and from Pampur, and that a Lower Palæolithic date is indicated. Considering that in recent years the evidence for Mid-Pleistocene and even late Pleistocene upheavals in the Himalayan zone has steadily accumulated—evidence to which Dr. de Terra himself has made such outstanding contributions—is it not at least a plausible hypothesis that the Zoji-La, if not other passes, afforded to Palæolithic man an easy traverse across the Himalayas?

For this evidence of geologically recent upheavals in northern India we can scarcely refer to a more authoritative source than Dr. de Terra[5] himself, who has corroborated and extended the work of his predecessors in the field, namely, Dainelli, Filippi, Middlemiss, Wadia and others.[6] Although a detailed account of his researches is still awaited, he has told us enough to confirm the old view that in the Himalayan zone the mountain-building movements initiated towards the close of the Mesozoic era continued, at intervals, till as late as the end of the Pleistocene and even into sub-Recent times, that is, till long after the advent of Man in northern India.

In his important work on Prehistoric India (1927, pp. 52–91) Professor P. Mitra of Calcutta has discussed in some detail the changing geological background of the history of primitive man in northern India. But it may not be amiss to give here a brief statement of the outstanding conclusions based upon recent work.

(*i*) The region of the Himalayas was once occupied by a Mediterranean ocean, the Tethys Sea, separating India (which probably lay south of the Equator) from the Eurasian land-mass in the north. Into this sea India sent out two great promontories: the Kashmir promontory on the N. W. (which according to Wadia was for some time connected to Eurasia by an isthmus) and the Assam promontory on the N. E.

(*ii*) Following an estimate by R. D. Oldham, de Terra concludes that the width of this ocean in Triassic times was at least 1,485 kilometres (930 miles).

(*iii*) Throughout the long ages from the Permian period till the end of the Eocene, the bed of this ocean was settling down under the weight of the accumulating sediments, totalling a thickness of well over 15,000 feet.

(*iv*) With the dawn of the Tertiary era the loaded ocean floor ("geosyncline") began to upheave: the sediments were squeezed, uplifted and folded into a mountain chain by the slow but irresistible movement, towards each other, of the northern and southern land blocks, between which they were caught up as in a vice.

(*v*) Round the resistant angular promontories the pile of sediments, folded somewhat like a Japanese fan, became bent

[4] He certainly had an extraordinary eye for fleeting line and form, and could give points to most of us in the delineation of running animals.

[5] de Terra, "Himalayan and Alpine orogenies," 1934, *Rep.* XVI, *Internat. Geol. Congr.*, Washington, 1933. See also *ibid.*, 1936, in *Nature*, April 25, pp. 686–688 and *Science*, March 6, pp. 233–236.

[6] References in de Terra, 1934, and in Wadia's works,

sharply to the southwest (into Hazara)[7] and to the south (into Burma).[8]

(*vi*) These "orogenic" or mountain-building movements continued, off and on, throughout the Tertiary era and far into the Quaternary or Pleistocene period, when the greater part of northern India came under arctic conditions during at least three epochs separated by warmer (interglacial) intervals.

(*vii*) Along the southern border of the mountains, at least, there is clear evidence that, as in the Alps, the folds of the strata followed like waves one behind the other, sometimes leaning over those in front. During the Middle Pleistocene "the Potwar basin was overthrust by Himalayan folds advancing southward,"[9] and in places broken off portions of the folds ("nappes"), composed of the oldest rocks from the Inner Himalayas, were carried horizontally for several miles to the southwest, riding over the folds of the much younger Siwalik strata.[10]

(*viii*) The final phase of uplift of the Himalayan mountain belt witnessed the folding and dragging up of the youngest Karewa beds on the Pir Panjal range by at least 6,000 ft. and the tilting of late Pleistocene lake terraces round Srinagar.[11] The effects of this upheaval were felt in the Potwar and even as far west as the Salt Range, which shows post-Pleistocene deformation.[12] Wadia records that between the Soan and Rawalpindi a thickness of some 5,000 feet of the upper Siwalik Boulder Conglomerate (which cannot be older than the Lower Pleistocene) have been tilted into a vertical position. These beds contain fossil bones of the elephant, horse, dog and other familiar animals. In addition Wadia found several hundred human artifacts, probably of Chellean age, which are also suspected to belong to the Boulder Conglomerate and would therefore show that the tilting movement must have taken place after the arrival of man in this part of the World. In the Salt Range, again, Wadia and Anderson have shown that strata as old as the Cambrian have been thrust over Siwalik beds of Late Pliocene age.

On various grounds Godwin-Austen based the opinion that "within a comparatively modern period, closely trenching upon the time when man made his appearance upon the face of the earth, the Himalaya has been thrown up by an increment approaching 8,000 or 10,000 feet."[13] *Indeed there are geologists who hold it as probable that this movement of uplift is still in progress.*[14] The frequent earthquakes felt all along the southern face of the Himalayas, parallel to the Great Boundary Fault (a plane, or rather a series of planes, of weakness in the strata from Baluchistan as far as Burma), may be cited as proof that stability has not yet been reached. A further argument is derived from the evidence of the far-reaching changes which have taken place in the drainage of the Indo-Gangetic plain within recent times.

The way in which the river systems of northern India responded to the changing aspect of the land has been described in an unusually clear and interesting paper by Wadia.[15] He supports the view of Pilgrim and Pascoe[16] that during early Pleistocene times the drainage of the present Ganges valley flowed *northwestwards* and was *discharged into the Indus* by a great prehistoric river. Of this river, variously called the Siwalik River or the Indobrahm (for the Brahmaputra was a tributary), the lower part is believed to have flowed along a northwest prolongation of the present Jumna river,

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[7] Wadia, "The Syntaxis of the N.W. Himalayas: its rocks, tectonics and orogeny," *Rec. Geol. Surv. Ind.*, 1931, LXV (ii).

[8] Sahni, "Permo-Carboniferous life-provinces, with special reference to India," *Curr. Sci.*, 1935, IV (6), 388–390, and literature cited; see esp. Figs. 2, 3. The view here expressed as to the southward continuation of the Himalayan mountains into Burma (as opposed to the idea of their eastward continuation into China, once suggested by Prince Kropotkin and J. W. Gregory and now advocated by Kingdon Ward) has been strongly supported on geological grounds by Mr. D. N. Wadia in a paper recently sent for publication in the *Himalayan Journal*. I have had the privilege of reading in advance this admirable exposition, by an acknowledged authority, of the origin and structure of the Himalayas.

[9] de Terra (1934), p. 8.

[10] Wadia (1931), pp. 215, 219.

[11] de Terra (1934), p. 9; Hawkes, Hawkes and de Terra (1934), p. 14.

[12] Wadia, "The Tertiary geosyncline of N.W. Punjab and the history of Quaternary earth-movements and drainage of the Gangetic trough," *Quart. Journ. Geol. Min. & Met. Soc. of India*, 1932, 4 (3); de Terra, 1934, p. 9.

[13] See Burrard and Heron, "A sketch of the geography and geology of the Himalaya mountains and Tibet," 1933, 2, 74.

[14] Wadia, "The trend line of the Himalayan range: its northwest and southeast limits," *Himalayan Journ.*, 1936 (*vide supra*, note 8).

[15] Wadia, 1932, pp. 86–95.

[16] References in Wadia, 1932.

and then through the broad but now almost deserted channel of the Soan River in the Potwar, to join the Indus near Makhad. With the differential earth movements which converted the old Potwar basin into a plateau, the Punjab section of the Siwalik River was severed from the upper part of the channel, *in which the flow of water became reversed and which became the modern Ganges.* Wadia writes, "There are both physical and historic grounds for the belief that the Jumna, during early historic times, discharged into the Indus system, through the now neglected bed of the Saraswati river of Hindu traditions."[17] In the low plateau, west of Delhi, which now forms the imperceptible watershed between the Indus and Ganges systems, there is plenty of evidence of a varied character in support of this popular belief.

To return to our point. All these changes in the physical background cannot but have exercised a profound influence upon the development of human cultures in northern India. Without more precise data (which a close study of the finely layered clays or "varves" in the Karewas of Kashmir[18] seems to promise) it would be rash to express an opinion about Godwin-Austen's view of the extent of the recent elevation of the Himalayas. But unless his figures are a gross overestimate (which to the present writer seems highly improbable) we have no reason to assume that the Himalayas or the Pir Panjal range were a barrier to the migration of Palæolithic or even Neolithic man.

On the view here adopted *northern India and China must have had direct contacts across the Himalayas since the dawn of human existence*, and the passes over these mountains probably mark some of the most ancient routes trodden by man. If, therefore, signs of Stone Age man were even to be found, say, on the Zoji-La itself, such a discovery would only be in accordance with expectation.

It is for the future to show how far these routes were used by the descendants of Neolithic man in India, that highly enterprising and intelligent race of people who flourished nearly 5,000 years ago in the Punjab, Sind and beyond, and who were among the first to learn the use of metals. Their distant connections to the west are now well established. They also employed materials of which the nearest known sources are far away in peninsular India. Their knowledge of *śilājīt* (a drug of obscure nature used in India since time immemorial) may well indicate that they had explored the Himalayas. And who knows but that the script of Harappa and Mohenjo-Daro, which still baffles the palæographer, will after all prove to have had early affinities with the ancient Chinese writings?[19]

Conclusion.

The main point of this article is that between India and China cultural contacts have probably existed since the very dawn of human existence. Long before man conquered the ocean intercourse between these two ancient countries was possible by the *direct route across the Himalayas* which, during Palæolithic and Neolithic times, were probably not so high as to form an effective barrier.

GULMARG,

July 1, 1936.

Postscript.—I have just read a brief report of the recent discovery by Dr. de Terra (*Science and Culture*, July 1936, 49–50) of an outpost of the "Indus" civilization in the valley of Kashmir, not far from the route connecting Srinagar with the Zoji Pass. The exact locality is the village of Burzahom, only a few miles north of the present site of Srinagar, a city which thus proves to have a far longer history than ever imagined.

This discovery lends point to the suggestion that we may hopefully look for an extension of this ancient culture, marking the end of the Neolithic period, even across the Zoji-La.

July 23, 1936.

[17] Wadia, *loc. cit.*, p. 93.

[18] As explained in a previous article, "The Karewas of Kashmir" (*Curr. Sci.*, July 1936).

[19] See C. L. Fábri, "Latest attempts to read the Indus Script," *Indian Culture*, I (i), p. 53, where the recent work of Dr. G. de Hevesy and of Professor Baron von Heine-Geldern is referred to.

Torrent Action Interferes with Canal Efficiency.

By R. Maclagan Gorrie, D.Sc., I.F.S.

MUCH discussion has arisen over the falling off in the winter levels of the larger Indian rivers, most of which are now utilised for irrigation. Although actual data have not yet been produced, there appears to be no doubt that the cold season flow of many of our Indian rivers has deteriorated to some extent, and the lack of water for the *rabi* (winter) crops is causing considerable anxiety and loss in various canal colonies. The problem applies throughout the drier half of India, and large sums have been invested by most provinces in irrigation and hydro-electric projects, whose success depends directly upon a sustained yield of water during the period of nadir flow.

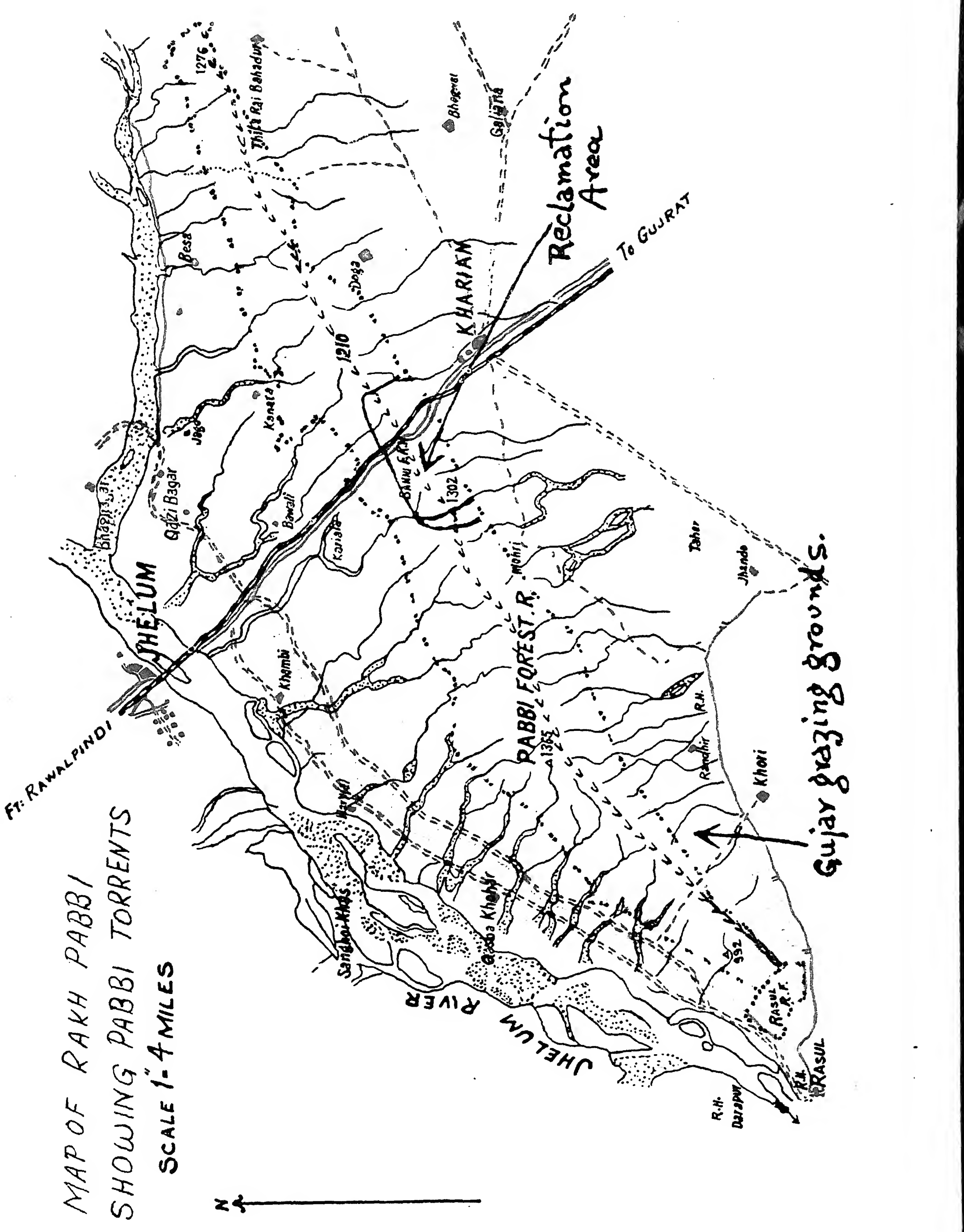
The popular opinion is that the winter flow depends upon the amount of rain and snow which falls subsequent to the monsoon period, but in actual fact the decrease in winter flow does not bear any direct relationship to precipitation, and the effect of snow-melt is more apparent in the later *kharif* (summer) irrigations. The major factor influencing the winter flow is not the actual precipitation but the capacity of the soil of the catchment area to absorb it. The typical Punjab catchment area is half in the high Inner Himalayas and half in the outer low foot-hills, and in both classes the absorptive capacity of the ground has, to a large extent, been interfered with through destruction of the plant cover which nature originally provided. Particularly in the lower foot-hills the damage to the grass and bush cover in the village grazing grounds has been systematic and cumulative over the last 60 years which have seen a gradual increase in the numbers of flocks of cattle, buffaloes, sheep and goats. The inevitable result is that the much abused ground is suffering everywhere from surface sheet washing and gullying, and with a falling off in porosity, the original soil profile has everywhere been destroyed and the present cover is less efficient as a sponge. A larger per cent. of the rainfall is therefore lost in flood peaks of dangerous and sudden intensity, followed by more rapid desiccation and a failure of the underground water-table which no longer receives its due share of the total precipitation.

These facts have long been known to many officials and engineers, and it is interesting to have them verified by actual statistics. A short account is therefore given below of one specific instance where torrent intensity has been measured and its effects correlated with these measurements.

Topography of the Pabbi Hills and Upper Jhelum Canal.

The Upper Jhelum Canal runs S.W. between the Jhelum river and the Pabbi Range for some 25 miles, then at Rasul it bends sharply round the toe of these hills and runs westwards for some 10 miles before any large distribution of water is undertaken. Throughout these 35 miles it is subject to serious interference from the action of torrents arising in the Pabbi range which is a single continuous ridge of low hills averaging 1,200–1,300 feet, the level of the Canal being about 800 feet and that of the Jhelum river bed about 730 feet. The Pabbies consist of very friable and easily eroded sand rock interstratified with beds of absolutely infertile red shale and an occasional bed of loose pebbly gravel. The whole range is badly cut up into steep ravines, the heads of which are cutting back into the watershed. Each torrent has very steep cliffs of hundreds of feet of bare soil at its head, while the intermediate ridges carry an open scrub growth of *phulai* (*Acacia modesta*) and a sparse cover of grass. The lower half of each torrent bed is a channel of shifting sand, widening out with the decreasing gradient as it passes beyond the forest reserve into the village lands where *barani* (non-irrigated) cultivation is done on both sides of the Canal. This belt of cultivation narrows considerably on the north face on approaching Rasul.

The Grand Trunk Road and the Railway from Lahore to Jhelum run parallel across the Range at about its middle and both pass through the Forest Department's Reclamation Area where since 1880 spasmodic efforts have been made to demonstrate torrent control and counter-erosion work. This area was originally taken up for protection of the road and railway against erosion but has been extended since 1921 and now covers some 3,500 acres. The remainder of the total of 38,000 acres of reserved forest is under a regime of passive protection, with grass cutting sold annually by blocks, and nominally complete closure to grazing. The control of illicit grazing varies inversely


MAP OF RAKH PABBI
SHOWING PABBI TORRENTS
SCALE 1"- 4 MILES
Reclamation Area
To GUJRAT
KHARIAN
JHELUM
Ft. RAWALPINDI
PABBI FOREST R.
Gujar grazing grounds.
JHELUM RIVER
Thith Rai Bahadur
Bhagwal
Galiana
Besa
Doga
Kanala
Qazi Bagar
Khambi
Mohri
Jhando
Khori
Rasul
Rasul R.F.
Sanghoi Khas
1276
1210
1302
1365
992

with distance from this Reclamation Area and from the Range Headquarters at Kharian, so that the extreme east and west ends of the reserve suffer most in this way. The outstanding example of the utter ruin which can be achieved by persistent over-grazing on such friable soil is found on the south face up to 6 miles east of Rasul. This area was unfortunately omitted from the reserve and is the common grazing for a group of Gujar villages (Khokra, Panjan, Khori, etc. of Dinga Tahsil). Although this is the lowest part of the Pabbi ridge and the slope is comparatively gentle, the whole of this Gujar area is now a vast expanse of shifting sand with the relics of *phulai* bucrs as the only stable element, the grass cover having been almost completely destroyed.

RUN-OFF DATA.

Accurate run-off figures for these torrents have been collected by the Irrigation Department since the beginnings of the Canal construction and show that the average maximum run off for 8 large torrents in the north face of the Pabbies under a regime of passive protection is 630 cusecs per square mile of catchment. Towards the toe at Rasul this rises to about 1,000 cusecs where the Canal runs closer to the Pabbi ridge. The toe of the range at Rasul yields 1,144 cusecs per square mile under a regime of grazing for at least half the year. The 4 outlets for the Gujars' grazing land yield an average maximum of 1,570 cusecs per square mile. At the other extreme, the "trained" streams of the Reclamation Area show a flood peak of roughly $\frac{1}{6}$th of the intensity of those under a passive protective regime, *i.e.*, about 100 cusecs per square mile of catchment, and cultivation is carried on regularly in the actual beds of these streams beyond and below the forest boundary, whereas in the untrained streams no cultivation is possible anywhere near the widest flood limits of their broad sandy beds.

Fig. 1.

Highest run-off maximum of 1570 cusecs per square mile is yielded by Gujar's grazing land on which the plant cover has been destroyed.

EFFECT OF TORRENTS ON CANAL CONSTRUCTION AND MAINTENANCE.

A. Level-Crossings.—To deal with the run-off from the largest torrents which cut across it at right angles, the Canal was given

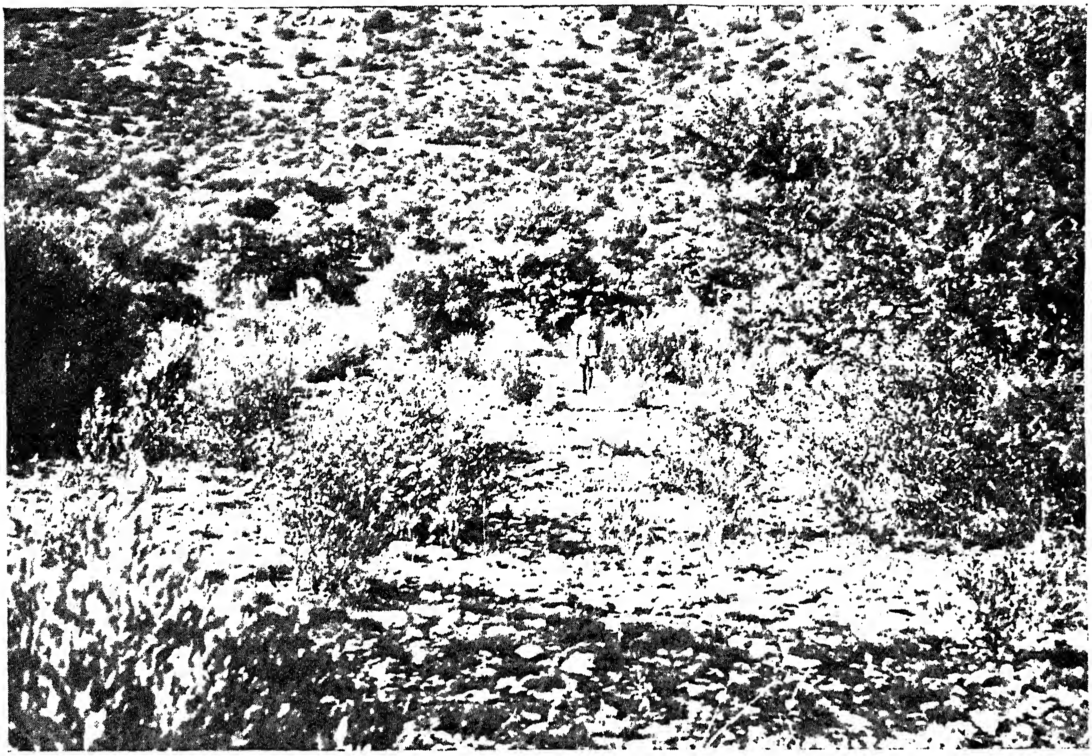


Fig. 2.

Medium run-off intensity of about 630 cusecs per square mile is yielded by scrub forest under an ordinary regime of protection to grazing but open to grass-cutting.

four "level-crossings". In these the worst torrents are passed across by allowing the torrent water to mingle with the Canal water and the excess from both is passed out over weirs. This saves any danger of breaching the Canal but entails a very heavy load of silt being passed into the Canal channel, as these torrents when in flood carry a very heavy load of sand and silt in suspension. The maximum floods recorded for these four *nalas* range from 42,000 to 105,000 cusecs. Silting from these level-crossings has increased to such an extent that in the 12 years prior to 1931, the Canal had actually lost 40 per cent. of its total carrying capacity and if no steps had been taken the active life of the Canal was estimated at only 15 years. In 1931 four silt extractors were installed at considerable expense to provide for the collection of silt in a series of wells in the bottom of the channel and its periodic ejection by washing into the adjoining and lower torrent channel. By this means further silting has been stopped but no definite gain has been registered, so that the Canal is still 40 per cent. below its true capacity, and the position is only just being maintained. The largest and most troublesome of these level-crossings is for the Jabba Kas, a huge torrent bed whose catchment area includes the whole of the eastern end of the north face of the Pabbies and an even larger area of eroding foot-hills in Kashmir territory.

B. Syphons.—The remaining torrents are provided for by 52 syphons. These are brick-in-mortar arched culverts which pass right under the Canal bed. As a brick arch will not stand any appreciable inside pressure, any sudden load of torrent water laden heavily with erosion debris is liable to burst it, thus virtually mining the Canal bed from below, and in order to reduce the danger of this, the Canal has to be kept running at more or less full capacity throughout the rains in order to keep an outside load upon these syphons. This in itself is a most undesirable feature because it aggravates the already serious problem of seepage. The value of torrent control and the

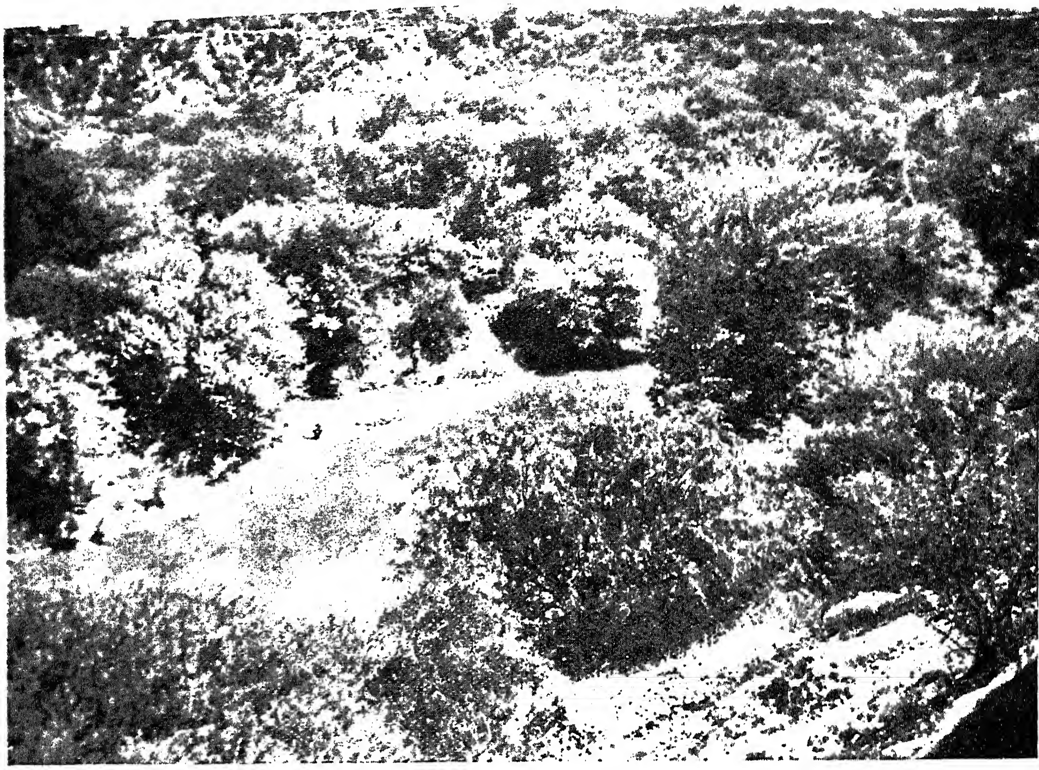


Fig. 3.

Lowest run-off maximum of about 100 cusecs or less per square mile is yielded by land improved by afforestation with mesquite trees and torrent training works.

reduction in peak floods, which has been proved possible under the Forest Department reclamation regime, is obvious. If the peak flood of each torrent can be distributed and passed down in six times the period normally taken by such torrents, the danger of bursting syphons would be largely eliminated and the Canal supply could be greatly reduced throughout the rains.

C. Underground Water-Table.—Looking upon the movement of underground water in the Upper Jhelum Canal area as a definite stream, this flows S. W. between the Jhelum on one side and the Bhimber and Chenab on the other, carrying with it the southern face drainage of the Pabbies and the seepage from the whole great bend of the Upper Jhelum Canal. The flat country around Dinga is incapable of dealing with such quantities of water, with the result that large areas remain flooded for about $2\frac{1}{2}$ months each year. The S. W. movement of the underground water carries this evil on into the main area served by the Canal, causing widespread water-logging. The six syphons draining the western toe of the Pabbies, namely Rasul, the four of the Gujar village block, and the adjoining Chimber which has a relatively small portion of its total catchment area in Reserved Forest, total together a catchment area of 16 sq. miles whose total maximum flood discharge amounts to 19,000 cusecs, all of which has to be handled in one branch of the Dinga drain which is capable of handling only 200 cusecs. From these figures it appears that these 16 sq. miles may be a very crucial factor in the local water-logging situation.

D. Certain Torrents Now Inactive.—Below Chimber the next seven syphons were built to carry very large flood peaks from the large area of comparatively flat ground bounded by the Pabbies to the north, the Lahore-Jhelum road to the north-east and the Bhimber *nala* watershed to the southeast. In the early days very large floods were actually recorded from what was then largely waste land. During the last 30 years this has been brought entirely under cultivation with a fairly efficient regime of

watt bandi (contour ridging), with the result that even for single catchment areas up to 45 sq. miles in extent, no severe floods have been recorded in the syphons for many years past. This is a rather remarkable result. Intensified cultivation methods, chiefly accurate terracing and properly maintained *watt bandi*, appear to be the main factor in effecting this change, though the training of three of the large south-face Pabbi torrents by the reclamation work above Kharian may also be to a smaller extent responsible for this.

SUGGESTED LINES OF TREATMENT.

With the data now available the various torrents can be classified according to their destructive tendencies, and reclamation work concentrated from the worst offenders. Such work in areas already closed to grazing consists of (i) "gully plugging" with a series of small stone bunds in the heads of each *nala* branch, not to store water but to delay the run-off; (ii) improvement of cover on all slopes by afforestation (iii) the training of the *nala* bed by planting its banks and bed with tall grasses. The object of all such work is to destroy the dangerous "peak" of sudden flood by distributing the run-off over a longer period and providing better conditions for seepage throughout the whole of the catchment. For non-forest land and areas subject to heavy grazing, the first essential is to get control of the grazing and effect a drastic reduction in the number of live-stock. Once this has been arranged, nature will herself improve the porosity by producing a better ground cover; where grazing has reduced the place to a waste of shifting sand, the natural process of recovery is a desperately slow one, but this can be hastened by the appropriate reclamation treatment.

I gratefully acknowledge the help given to me by Mr. E. S. Crump, C.I.E., I.S.E., in presenting the above data.

The Genes of *Triticum Timopheevi* Zhuk., *Secale cereale* L. and *Haynaldia villosa* Schur.

By Prof. Dr. Dontcho Kostoff.

(*Academy of Sciences of U.S.S.R, Institute of Genetics, Moscow.*)

THE basic chromosome number of the genus *Triticum* and its allied genera (*Secale*, *Haynaldia*, *Aegilops*, *Agropyrum*, *Elymus*, etc.) is 7. The species of the genus *Triticum* are divided into three groups according to the chromosome number, namely, (1) diploid wheats or *monococcum* group with $n = 7$, $2n = 14$, (2) tetraploid wheats or *durum* group with $n = 14$, $2n = 28$, and (3) hexaploid wheats or *vulgare* group with $n = 21$, $2n = 42$ chromosomes. The gene of the diploid group consisting of 7 chromosomes is designated with A or the whole gene formula of the diploid wheats is AA. Tetraploid wheats have gene A of diploid wheats and another gene designated with B. Hence the gene formula of the tetraploid wheats will be AABB. Hexaploid wheats contain both (A and B) genes of the tetraploid wheats, and in addition to these another gene, designated with C. (Japanese investigators designate this gene with D.) The formula of the hexaploid wheats will be then AABBCC. These gene formulas were stated by Sax (1921), Kihara (1924–1934) and many others.

In 1923 Zhukovsky found in Georgia a new wheat form and described it first as a variety of *Tr. dicoccoides* Schul., (1923), while 5 years later (1928) he gave it the specific name *Triticum Timopheevi* Zhuk. It has $n = 14$, $2n = 28$ chromosomes.

Interspecific crosses between *Tr. Timopheevi* and the other species of *Triticum* were produced with difficulty. The hybrids obtained were usually self-sterile. Single grains were rarely obtained from *Tr. vulgare* × *Tr. Timopheevi* and from *Tr. persicum* × *Tr. Timopheevi* hybrids, while the hybrids amongst the other tetraploid species (AABB) are usually fully fertile. The pentaploid hybrids (AABBC) are partially fertile, *i.e.*, more fertile than the hybrids AABB × *Tr. Timopheevi* and AABBCC × *Tr. Timopheevi*.

Such a peculiar behaviour of *Triticum Timopheevi* suggested the idea of studying the behaviour of the genes of this species. In the triploid hybrids produced by crossing *Tr. monococcum* (AA) with *Tr. Timopheevi* and *vice versa*, the chromosomes with gene A, form most frequently chiasmata with 7 chromosomes of *Tr. Timopheevi*, while the other 7 chromosomes remain as univalent.

(Less than 7 bivalents, as well as trivalents occasionally occur. More detailed description will be given elsewhere—see Kostoff 1936, *a. b.*) Hence *Tr. Timopheevi* has, roughly speaking, one gene homologous with gene A.

In order to study the relations between the second gene of *Tr. Timopheevi* in respect to the other two *Triticum* genes (B and C) crosses were made between AABB *Triticum* species and *Triticum Timopheevi* as well as between AABBCC *Triticum* species and *Triticum Timopheevi*. Both tetraploid as well as pentaploid hybrids were successfully produced with *Tr. Timopheevi* (Kihara and Lilienfeld did not succeed in producing pentaploid hybrids).

Cytological studies of the chromosome behaviour during the I metaphase in the PMC (pollen mother cells) of *Tr. Timopheevi* × *Tr. durum* var. *melonopus* and *Tr. Timopheevi* × *Tr. persicum* var. *stramineum* showed that various number of chromosomes with the second gene of *Triticum Timopheevi* conjugate with gene B of *Tr. durum* and *Tr. persicum*; therefore it was called β-gene. It should be noted here that many more chromosomes with gene β formed chiasmata with the chromosomes having gene B of *Tr. persicum*, while somewhat less of them formed chiasmata with the chromosomes

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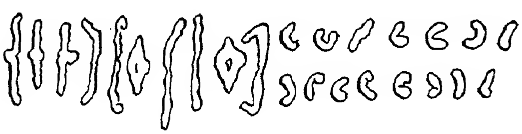

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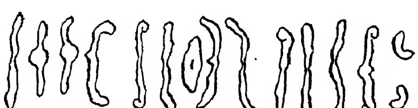

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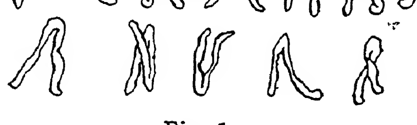

Fig. 1.
The Chromosomes from a pollen mother cell of the hybrid *Tr. compactum* × *Tr. Timopheevi*—10 bivalents and 15 univalents.

Fig. 2.
The chromosomes from a pollen mother cell of the hybrid—*Tr. Timopheevi* × *Tr. persicum*—13 bivalents and 2 univalents.

Fig. 3.
Polyvalent chromosomes from various cells *Tr. Timopheevi* × *Tr. persicum*.

having gene B of *Tr. durum*. In the hybrid *Timopheevi* × *persicum* — 10–12 bivalents were found. In single cells even 14 were observed. (Polyvalents occurred too.) In the hybrid *Timopheevi* × *durum*, however, 9–10 bivalents were most frequently observed. (Detailed description will be given elsewhere—Kostoff 1936, *a. b.*) The chiasma formation between the chromosomes having gene B of the tetraploid wheat species with those having the gene of *Tr. Timopheevi* indicate that this gene is partially homologous with gene B. It should be mentioned here that gene β was designated by Kihara and Lilienfeld (1934) with G and considered as non-homologous with B, their data, however, were almost similar to that we obtained.

The pentaploid hybrids (AABβC) between *vulgare* wheat (AABBCC) and *Tr. Timopheevi* (AA$\beta\beta$) had about the same number of bivalents as those observed in the tetraploid hybrids (AABβ) between *durum* wheats (AABB) and *Tr. Timopheevi*. (Detailed description will be given elsewhere—Kostoff 1936, *a. b.*) These observations indicate that the gene is not homologous with gene C.

It was interesting to find out the relations between the genes of *Triticum* and those of *Secale cereale* ($n = 7$, $2n = 14$), gene S and *Haynaldia villosa* ($n = 7$, $2n = 14$), gene V. Therefore a series of hybrids were produced and cytologically investigated.

The studies of the hybrid *Tr. dicoccum* × *Haynaldia villosa* showed that 0, 1, or 2 bivalents with one chiasmata usually occur in the I metaphase of the PMC's. These observations showed that V gene of *Haynaldia* is not homologous with A and B genes of *Triticum*. In studying the hybrid *Tr. vulgare* var. *Novinka* × *Haynaldia villosa* (*i.e.*, ABCV) somewhat more bivalents were found, but they seem to be rather due to *autosynthesis* between the chromosomes having A, B and C genes than to *allosynthesis* between the chromosomes with C and V genes. (Detailed description will be given elsewhere.) In the hybrid *Tr. Timopheevi* × *Haynaldia villosa* (*i.e.*, AV) 0, 1, 2 and 3 bivalents were observed. It seems that β-gene has somewhat greater affinity with V gene, than A and B genes, but since, very often, only univalents were found in the hybrid *Tr. Timopheevi* × *Haynaldia villosa*, we can safely infer absence of homology between β- and V genes.

Secale cereale (S) gene behaves in a similar way to the gene of *Haynaldia*

villosa (V). In studying the hybrids *Tr. turgidum* × *Secale cereale* (*i.e.*, ABS) and *Tr. vulgare* × *Secale cereale* (*i.e.*, ABCS) we obtained data which showed that S gene is not homologous with genes A, B and C of *Triticum*. Similar data were reported by other students (Lebedeff, 1932; Müntzing, 1935, etc.). The relation between the *Secale* (S) gene, and β-gene of *Tr. Timopheevi* was not however studied. Kihara and Lilienfeld's attempts to cross *Tr. Timopheevi* with *Secale cereale* were unsuccessful. We raised in 1935 two hybrids *Tr. Timopheevi* × *Secale cereale* (*i.e.*, AβS). It was possible to study cytologically one of them. The absence of bivalents in the I metaphase of PMC's in the hybrid and the appearance of only one or sometimes of two bivalents with one terminal chiasma showed that β-gene is not homologous with S gene.

But what is then the relation between V gene (of *Haynaldia villosa*), and S gene (of *Secale cereale*)? Numerous attempts were made to cross *Secale cereale* with *Haynaldia villosa* but they were always unsuccessful. We produced, in 1931, only one hybrid and it died at an early stage of development. Recently, we followed another way in combining the gene of *Secale cereale* (S) with that of *Haynaldia villosa* (V), namely, by using a bridge species. *Tr. dicoccum* served as one such. In crossing the hybrid *Tr. dicoccum* × *Haynaldia villosa* (*i.e.*, ABV) with *Secale cereale* (S) a trigeneric triple hybrid with 28 chromosomes (ABVS) was produced which contained all A, B, V, and S genes. In studying the meiosis of this hybrid we found usually 28 univalent chromosomes, or 1 bivalent and 26 univalents. Such a behaviour of the chromosomes during the I metaphase of the trigeneric hybrid shows that gene S is not homologous with gene V. (Detailed description will be given elsewhere by Kostoff and Arutinnova.)

Kihara, H., *Mem. Coll. Sci. Kyoto Imp. Univer. Ser.*, 1924, B, 1.

Kihara, H., *Genomanalyse bei* Triticum und Aegilips. V; Lilienfeld, F., und Kihara, H., *Cytologia*, 1934, **6**, 87–122.

Kostoff, D., *Chromosome behaviour in* Triticum *hybrids and allied genera*, 1936, I, II, and III (In press).

Müntzing, A., *Hereditas*, 1935, **20**, 137–169.

Sax, K., *Genetics*, 1921, 6.

Sax, K. *Genetics*, 1922, 7.

Zhukovsky, P. M., *Ber. Tifl. Bot. Gart.*, III. (Russian), 1923.

Zhukovsky, P. M., *Bull. Appl. Bot.*, 1928, 19.

The Photoisomerides of Ergosterol.

By I. M. Heilbron and F. S. Spring.

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IT is not the intention of this resumé to trace the history of the recognition and characterisation of vitamin D (the antirachitic accessory food factor),[1] but rather to deal with the chemistry of calciferol. It is necessary, however, at the outset to emphasise that abundant evidence has accumulated which shows that vitamin D of cod-liver oil and other natural sources is not identical with calciferol, the antirachitic photoisomeride of ergosterol.[2]

That ergosterol on irradiation is converted into a material with strong antirachitic activity was demonstrated independently by Rosenheim and Webster,[3] and by Windaus and Hess.[4] The first crystalline photoisomerides of ergosterol to be isolated were the suprasterols I and II formed by prolonged irradiation of a solution of ergosterol[5]; they are physiologically inactive and no longer exhibit selective absorption in the ultraviolet region of the spectrum. If however, ergosterol be carefully irradiated to give a product of maximum physiological activity, unchanged ergosterol can be removed by taking advantage of the fact that the irradiation products, in contrast to ergosterol, are not precipitated by digitonin. Bourdillon *et alia*,[6] isolated a crystalline product with a high antirachitic potency by high vacuum sublimation of the resin so obtained; this product was later shown to be a mixture of calciferol, m.p. 114–117°, possessing an enhanced antirachitic activity, and a physiologically inactive pyrocalciferol.[7] Almost

[1] For such a summary see Heilbron, *J. Soc. Chem. Ind.*, 1936, **55**, 1219.

[2] Steenbock, *et alia*, *J. Biol. Chem.*, 1932, **97**, 249; Ender, *Z. Vitaminforsch.*, 1933, **2**, 241; Rygh, *Nature*, 1935, **136**, 396.

[3] *Biochem. J.*, 1927, **21**, 389.

[4] *Nachr. Ges. Wiss., Göttingen*, 1927, 175.

[5] Windaus, Gaede, Köser and Stein, *Annalen*, 1930, **483**, 17.

[6] *Proc. Roy. Soc.*, B, 1930, **107**, 76.

[7] Askew, Bruce, Callow, Philphot and Webster, *Proc. Roy. Soc.*, B, 1932, **109**, 488.

simultaneously, Windaus and Deppe[8] observed that the ergosterol free-resin obtained by irradiation with "long-wave" light (the unfiltered light of the mercury arc) on treatment with citraconic anhydride at room temperature followed by removal of the acidic fraction, gave a crystalline compound, "vitamin D_1" which possesses a high antirachitic activity. Later,[9] it was observed that if the unfiltered light of the magnesium arc be used (main emission at 278–280 $m\mu$) for the irradiation process, the ergosterol-free resin so obtained after treatment with citraconic anhydride gave a crystalline antirachitic factor, vitamin D_2, identical with the calciferol of Askew, Bourdillon, *et alia*[7]; it possesses a physiological activity considerably greater than that of vitamin D_1.

The problem then resolved itself into whether irradiation of ergosterol gives more than one antirachitic factor or whether vitamin D_1 is a mixture. The latter was found to be the case when vitamin D_1 was resolved by fractionation of its dinitrobenzoate into calciferol (vitamin D_2) and a physiologically inactive isomer to which the name lumisterol was given.[10] Yet another photoisomeride of ergosterol was obtained by examination of the fraction of the resinous irradiation product from ergosterol which reacts with citraconic anhydride.[11] Because of the ease with which it combines with citraconic anhydride this new isomeride is called tachysterol; it is antirachitically inactive and toxic, producing calcification in the kidney.

Thus although irradiation of ergosterol produces a series of photoisomerides, only calciferol (vitamin D_2) has the property of controlling normal calcification. In order to facilitate a chemical study of the constitution of calciferol it is clearly important to establish whether the various isomerides are formed simultaneously, representing individual reactions, or whether they are stages in a continuous transformation. Irradiation of lumisterol has been shown to give tachysterol, calciferol and the suprasterols I and II, whilst irradiation of tachysterol gives calciferol and the suprasterols I and II. Further irradiation of calciferol gives only the suprasterols I and II, which are unchanged by further irradiation.[12] Thus the photochemical process may be represented by the scheme :—

$$\text{Ergosterol} \rightarrow \text{Lumisterol} \rightarrow \text{Tachysterol} \rightarrow \text{Calciferol} \rightarrow \left\{\begin{array}{l}\text{Suprasterols I and II.}\\ \text{Toxisterol.}\end{array}\right.$$

In the "short-wave" irradiation of ergosterol, lumisterol is not formed; toxisterol is the name given to a probable photoisomeride of ergosterol, the existence of which is inferred from the appearance of high toxicity and a band at 240 $m\mu$ during the over-irradiation of calciferol.

Chemical Investigation.—For details of the methods by which the constitution of ergosterol (I) has been established the reader must be referred to the original literature.[13] The photoisomerides of ergosterol all resemble the latter in possessing a side chain ethylenic linkage since each gives methyl*iso*propylacetaldehyde on ozonolysis.[14] The constitution of lumisterol has been, to a large measure, established by the observations that it is tetracyclic, containing three ethenoid linkages,[15] and that it gives 3-methyl*cyclo*pentenophenanthrene on dehydrogenation with selenium[16]; thus it must contain the normal sterol condensed ring system. In addition to an ethylenic linkage between C_{22} and C_{23} a second ethylenic linkage has been located between C_5 and C_6, an observation which automatically locates the remaining unsaturated centre at C_7–C_8 since lumisteryl acetate gives an adduct with maleic anhydride and must therefore contain a conjugated system of ethenoid linkages.[17] Since lumisterol is not precipitated by digitonin, it is highly probable that in contrast to ergosterol the hydroxyl group has the *epi*-configuration; lumisterol (II) probably differs from ergosterol in the arrangement of the groups associated with C_3 and C_9 (and/or C_{10}).

Calciferol and Tachysterol.—That tachysterol in contrast to ergosterol and lumisterol contains four ethylenic linkages was demonstrated by the method of perbenzoic acid

[8] *Annalen*, 1931, **489**, 252.

[9] Windaus, Linsert, Lüttringhaus and Weidlich, *Annalen*, 1932, **492**, 226.

[10] Windaus and Linsert, *Annalen*, 1931, **489**, 269.

[11] Windaus, Werder and Lüttringhaus, *Annalen*, 1932, **499**, 188.

[12] Setz, *Z. Physiol. Chem.*, 1933, **215**, 183.

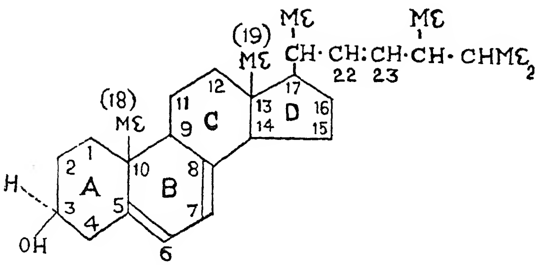
[13] Windaus, Inhoffen and Reichel, *Annalen*, 1934, **510**, 248; Dunn, Heilbron, Phipers, Samant and Spring, *J. Chem. Soc.*, 1934, 1576.

[14] Guiteras, *Annalen*, 1932, **494**, 116.

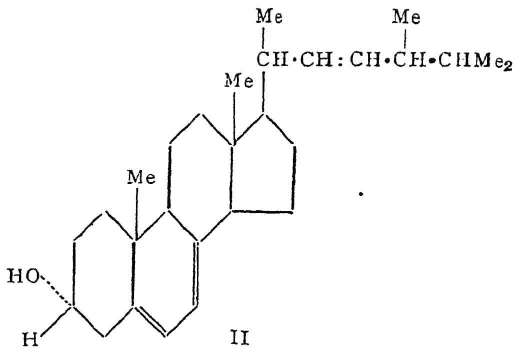
[15] Heilbron, Spring and Stewart, *J. Chem. Soc.*, 1935, **1221**.

[16] Dimroth, *Ber.*, 1935, **68**, 539.

[17] Heilbron, Moffet and Spring, (unpublished observation).



I



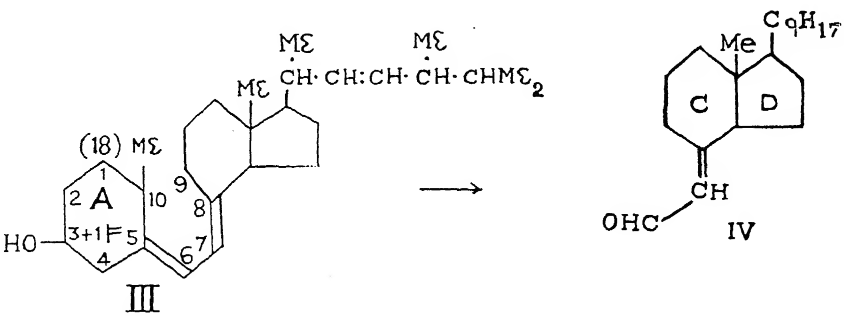
II

titration.[18] It was subsequently shown that calciferol is likewise tetraethenoid both by perbenzoic titration[19] and by catalytic hydrogenation.[20] Calciferol and tachysterol must possess the same nuclear structure since each on reduction with sodium and alcohol give one and the same dihydro-derivative.[21]

Since both ergosterol and lumisterol are tetracyclic it follows that their transformation into tachysterol and calciferol must be accompanied by the rupture of a ring with the consequent appearance of a fourth ethylenic linkage. It is clear that the conjugated system of ethylenic linkages in both ergosterol and lumisterol is the most probable seat of the photochemical change, thus leading to six possible nuclear structures for calciferol and tachysterol according to the mode of rupture of ring B.[19]

formation of this aldehyde (IV) clearly shows that calciferol has the structure (III), in which the remaining ethylenic linkage must be associated with ring A.

This constitution has been confirmed and extended by an independent method.[23] Calciferol gives two isomeric adducts with maleic anhydride, which on partial hydrogenation give dihydro-derivatives. Ozonolysis and selenium dehydrogenation of these derivatives give respectively a ketone, $C_{19}H_{34}O$, and 2 : 3-dimethylnaphthalene respectively. These reactions can only be interpreted if structure (III) for calciferol be expanded to (V) in which the ring A ethylenic linkage is situated between C_{10} and C_{18}. The presence of such an exocyclic methylene group has been demonstrated by ozonolysis of calciferol when formaldehyde is obtained together



The first evidence concerning the nature of this tricyclic nucleus was obtained by oxidation of calciferol when an $\alpha\beta$-unsaturated aldehyde $C_{21}H_{34}O$, was isolated.[22] The

with a keto-acid, $C_{13}H_{20}O_3$ (V*a*).[24] There can thus be no manner of doubt that calciferol is correctly represented by (V).

It is probable that if a sterol contains a conjugated system of ethylenic linkages in positions C_5–C_6 and C_7–C_8 it can be transformed into an antirachitic factor by

[18] Lettré, *Annalen*, 1934, **511**, 280.

[19] Heilbron and Spring, *J. Soc. Chem. Ind.*, 1935, **54**, 795.

[20] Kuhn and Möller, *Z. angew. Chem.*, 1934, **47**, 145.

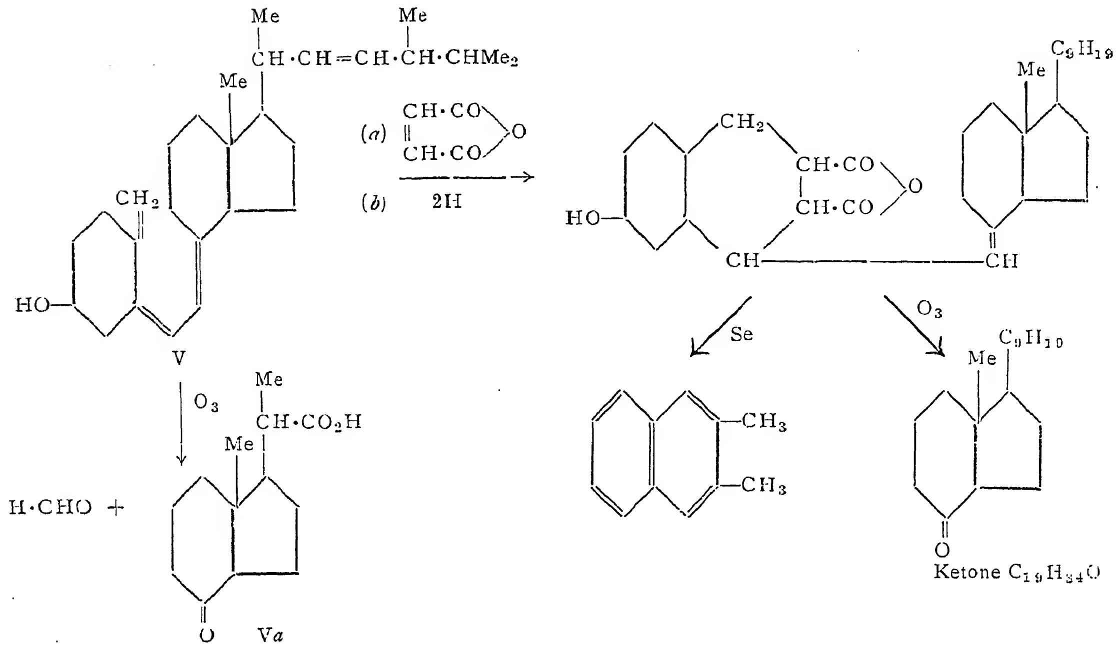
[21] Müller, *Z. physiol. Chem.*, 1935, **233**, 222.

[22] Heilbron, Samant and Spring, *Nature*, 1935, **135**, 1072; *J. Chem. Soc.*, 1936 (in press).

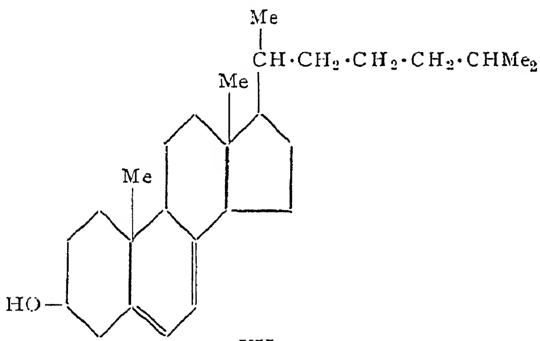
[23] Windaus and Thiele, *Annalen*, 1935, **521**, 160.

[24] Heilbron, Jones and Spring, (unpublished observation).

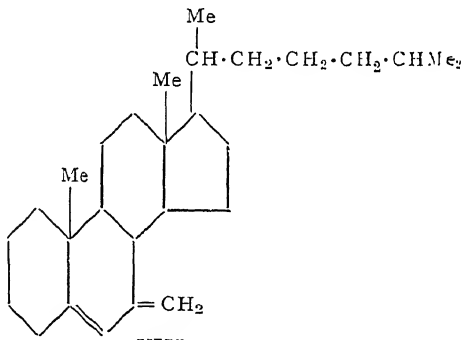
3



irradiation with ultra-violet light. Thus the synthetic 7-dehydrocholesterol (VII)[25] is converted into a highly antirachitic product on irradiation, whereas the synthetic 7-methylene cholesterol (VIII) is antirachitically inactive after similar treatment.[26] It has been reported however, that 7-dehydrostigmasterol is comparatively inactive after irradiation.[27]



VII



VIII

[25] Windaus, Lettré and Schenck, *Annalen*, 1935, **520**, 98.

[26] Bann, Heilbron and Spring, (unpublished observations).

[27] Lettré and Inhoffen, Sterine, Gallensauren, etc., *Stuttgart*, 1936, p. 312.

LETTERS TO THE EDITOR.

CONTENTS.

Soft X-Rays and Photoelectrons from Nickel at Different Temperatures.

TARTAKOWSKY AND KUDRJAWZEWA[1] found that the secondary electron current from heated nickel showed a sudden decrease at the Curie point (358° C.). They inferred that the conduction electrons emitted when the metal was bombarded were also responsible for the ferromagnetism of the metal. Hayakawa[2] utilised this method to study transformations in metals and metallic alloys. He has reported the existence of a critical potential for each ferromagnetic metal, the variation of the secondary current changing sign as the applied potential is increased to values higher than this critical voltage. He has accounted for the existence of such critical values from the point of view of Richardson's structure electrons.[3]

The close connection between the soft X-ray excitation on the one hand and secondary electron emission and photoelectric activity on the other, has been the subject of extended investigation in Professor Richardson's laboratory in London.[4] The question hence arises as to whether any sudden variations exist in the soft X-ray excitation and photoelectric efficiency of ferromagnetic metals as their temperatures are raised beyond the Curie point. Nickel was chosen for special investigation.

The experimental tube was of pyrex. The electrical connections were similar to those employed by Richardson and Rao[5] in their study of soft X-rays from metals. The working pressure was maintained below 10^{-6} mm. as indicated by a Macleod gauge.

The photoelectric efficiencies of copper and nickel when exposed to soft X-radiation (applied potentials of 100 and 150 volts) were found to be independent of temperature in the range 30° to 500° C. These results agree with similar observations made in the optical region.[6]

The soft X-ray intensity from well degassed polycrystalline nickel increased with temperature gradually at first and more rapidly at higher temperatures. No abrupt change in intensity was observed at the Curie point of nickel.

A comparative study was also made of the photoelectric efficiencies of polycrystalline nickel and a single crystal of nickel with 110 face. The photoelectric efficiency of the 110 surface was found to be smaller than that of the polycrystalline nickel face by about 12 per cent. This interesting observation can be accounted for in the following manner.

Nakaya[7] has shown that a heavy bombardment on a well-polished metal has the same effect as etching and that the crystal facets are brought out in the process. We have X-ray evidence[8] to show that the structure at the boundaries of the large number of crystals developed during bombardment is considerably distorted. Hence it is likely that the photoelectric emission (as also secondary emission) from these regions is much greater than from regions of more perfect structure,

These considerations lead one to the conclusion that the increase in the secondary emission observed by Hakayawa at the Curie point (at potentials above the critical value) should be due to an increase in the number of electrons returning with the same velocity as the primaries or with a slightly decreased velocity. This would mean that the energy of the structure electrons responsible for the conservation of spin in the micro-crystals of Heisenberg shows a sudden decrease at the Curie point and that these electrons are more easily driven out of the metal, thus enhancing the secondary electron current.

S. RAMACHANDRA RAO.
Annamalai University,
August 3, 1936.

[1] *Zeits. f. Phys.*, 1932, **75**, 137.
[2] *Sc. Rep. Tohoku Imp. Univ.*, 1933, **22**, 934.
[3] *Proc. Roy. Soc.*, 1930, **128**, 63.
[4] See innumerable papers in the *Proc. Roy. Soc.*
[5] *Proc. Roy. Soc.*, 1930, **128**, 16.
[6] Allen, *Photoelectricity* (Longmans).
[7] *Proc. Roy. Soc.*, 1929, **124**, 616.
[8] Elam, *Distortion of Metal Crystals*, 1935.

Oberbeck's Vortices in Air.

OBERBECK'S vortices in water were studied by one of the authors.[1]

A study of these in air was made on similar lines by using smoke as the tracing fluid. A beam of sunlight was incident in the direction of travel of the vortex. The beam was periodically interrupted by a rotating shutter and the smoke streaks were photographed by a powerful camera by means of the light scattered by them. By suitably controlling the interval between successive exposures overlapping of the several stages on the photographic plate was avoided. Fig. 1 shows a typical record.

Fig. 1.

Fig. 2.

All relevant data such as the number of convolutions, the distance travelled, and the time required are thus obtained at one stroke.

Increase in the quantity of air let out through the generating tube brings out generally a number of vortex rings at once. By suitably controlling the conditions of flow only two rings would be obtained.

Fig. 2 shows two stages of the rings obtained on a film kept in continuous rotation.

It was observed that the two rings were essentially different in their origin. The first one started from the very end of the tube and travelled on, the number of convolutions increasing.

The second one, however, originated at a fixed distance (as far as could be ascertained visually) away from the tube. Its progress was not so rapid as that of the first.

To the knowledge of the authors the difference is striking and further work in this connection is in progress.

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V. S. DUBHASHI.

Physics Department,
Fergusson College,
Poona,
July 18, 1936.

[1] *Phil. Mag.* 1931, **11**, 1057.

A New Method of Oximation.

HAQ, RÂY AND TUFFAIL-MALKANA[1] showed that anthraquinone and histazarine dimethyl ether readily gave oximes in pyridine solution. Later on, Cook, Hewett and Lawrence[2] prepared the oxime of *trans*-hexahydroanthrone by following an identical procedure but made no reference to the earlier work. They, however, gave publicity to the usefulness of this method of oximation in difficult cases. This method is particularly suitable for the preparation of those oximes which are formed with great difficulty.

It has now been found that flavone and α-napthaflavone react with hydroxylamine in aqueous pyridine solution under the following conditions:

A mixture of flavone (0·1 g.), hydroxylamine hydrochloride (0·15 g.) in water (0·5 c.c.), pyridine (1 c.c.) was refluxed on a sand-bath for 4 hrs. and then poured into dilute acetic acid when cold. The precipitated solids crystallised from hot dilute acetone in colourless needles, m.p. 237°. Yield quantitative. Found: N, 5·95; $C_{15}H_{11}O_2N$ requires N, 6·19%. Similarly, α-naphthaflavone gave the substance $C_{19}H_{13}O_2N$ (colourless needles, m.p. 181° after crystallisation from hot dilute acetone) on similar treatment. Found: N, 4·85; $C_{19}H_{13}O_2N$ requires N, 4·8%.

The structure of these substances are under investigation but presumably they are true oximes.

K. C. GULATI.
J. N. RAY.

The University,
Lahore,
July 15, 1936.

[1] *J.C.S.*, 1934, 1328.

[2] *J.C.S.*, 1936, 79.

Nutritive Value of Parboiled Rice.

IN recent years, considerable amount of attention has been drawn to the high nutritive value of parboiled rice. Evidence has been adduced to show that during the process of parboiling vitamin B_1 penetrates into the endosperm layers so that in spite of even high polishing, the anti-neuretic vitamin is not entirely lost.[1-5]

The basis of the general nutritive value of parboiled rice has so far remained rather obscure. The observations of McCarrison and Norris,[6] Joachim and Kandiah,[7] Codd and Peterkin,[5] Basu and Sarkar[8] and others would indeed suggest that parboiled rice is not very different in composition from raw rice derived from the same variety. Recent studies by the present authors would show that parboiled rice polished to the same degree is generally slightly richer in both Nitrogen and Phosphorus than the corresponding specimens of raw rice.

This would not however entirely account for the superior nutritive value of parboiled rice to that of raw rice.

It is well known that irrespective of the variety chosen, parboiled rice is generally darker in colour than the corresponding raw rice. The colouring matter (which is derived in part from the husk) can be removed to some extent by polishing, but the final product rarely ever attains the desired degree of whiteness. In view of this and the fact that parboiled rice is generally consumed by the poorer classes of people,

it is milled to a less extent (about 5 per cent.) than raw rice (15–20 per cent.).

It may be seen from Table I, that between 5 and 15 per cent. of polishing, a large part of the nitrogen and phosphorus of the hulled rice are lost. As already explained, this portion is generally preserved in parboiled rice so that it becomes very much richer in these two valuable constituents than polished, raw rice of commerce.

TABLE I.

Nitrogen and Phosphorus contents of Raw and Parboiled Rice Polished to Different Degrees.

Raw Rice			Parboiled Rice		
Degree of polishing (*per cent.*)	Nitrogen as mg. per 100g.	Phosphorus as mg. per. 100 g.	Degree of polishing (*per cent.*)	Nitrogen as mg. per 100g.	Phosphorus as mg. per 100 g.
Variety Adt. 11.					
Unmilled	1114	160	Unmilled	1138	160
1·0	1103	154	2·0	1111	148
2·0	1092	147	3·8	1092	136
3·7	1061	134	5·3	1077	127
5·5	1038	122	6·6	1064	118
7·3	1015	109	8·1	1046	107
8·8	996	98	9·2	1030	98
10·8	973	85	11·4	1000	79
12·8	949	74	13·4	971	60
15·8	914	59	15·4	939	44
19·3	871	33	18·4	894	20
24·3	830	25	23·4	841	—
Variety Co. 9.					
Unmilled	1239	366	Unmilled	1269	360
2·0	1227	334	2·5	1252	325
3·8	1214	300	4·0	1242	298
6·3	1194	251	7·0	1220	246
7·8	1180	221	9·2	1201	201
9·3	1164	193	10·7	1188	172
11·7	1139	151	12·7	1163	124
13·4	1121	124	14·5	1105	75
14·6	1107	107	15·7	1086	55
16·3	1089	85	16·7	1070	31
18·6	1060	73	19·2	1040	20
23·6	1038	—	23·2	1009	—

Parboiled rice is generally poorer in fat than raw rice polished to the same degree. This would account for the slightly better keeping quality of the former. During parboiling, the starch gets partly gelatinised so that, on cooking, parboiled rice tends to stiffen more readily than raw rice. This would account for the better keeping quality of cooked parboiled rice, especially when stored under water.

Parboiled rice of commerce is generally prepared out of the so-called coarse or coloured varieties of rice as also those which tend to get readily broken on milling. (The milling quality of rice is greatly improved by parboiling). The recent observations of the authors would show that some of the coloured varieties (and coarser varieties in general) have thicker bran layers and contain very much more of nitrogen and phosphorus than the superior white varieties. This may also have some bearing on the high nutritive value of parboiled rice.

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H. P. DAS GUPTA.

Department of Biochemistry,
Indian Institute of Science,
Bangalore,
July 7, 1936.

[1] Douglas, C. E., *Empire Marketing Board Report*, 1930, No. 32.

[2] Aykroyd, W. R., *Jour. Hygiene*, 1932, **32**, 184.

[3] Ghosh, S., and Dutt, A., *Ind. Jour. Med. Res.*, 1933, **20**, 863.

[4] Acton, H. W., Ghosh, S., and Dutt, A., *Ind. Jour. Med. Res.*, 1933, **21**, 103.

[5] Codd, L. E. W., and Peterkin, E. M., *Brit. Guiana, Dept. of Agric., Rice Bulletin*, 1933, No. 1.

[6] McCarrison, R. and Norris, R. V., *Ind. Med. Res. Memoirs*, 1924, No. 2.

[7] Joachim, A. W. R., and Kandiah, S., *Trop. Agric.* (Ceylon), 1928, **70**, 2.

[8] Basu, K. P., and Sarkar, S. N., *Ind. Jour. Med. Res.*, 1935, **22**, 745.

Respiration of Ripening Tomatoes.

IT has been accepted by plant physiologists that in the development of fruits the intensity of respiration as measured by CO_2 evolution supplies a general indication of the magnitude of metabolism. In fruits, it has been found that the ontogenetic metabolic drift from adolescence through maturity to death is represented in respiration by a curve which shows two high values separated in time: one is initial and represents a high rate of respiration in young fruits, the other occurring at the onset of senescence, known as the climacteric, is generally associated with the change in

colour during ripening. The causes underlying the climacteric rise in respiration of ripening fruits are not fully understood. Blackman and Parija[1] explained the rise in respiratory activity in apples on the assumption that in the senescent stage a lowering of "hydrolysis-resistance" occurs leading to a greater production of substrate for respiration. Kidd and West[2] have attributed the initial increase in CO_2 output during senescence to the action of some "protoplasmic factor". Gustafson[3] suggests that the climacteric rise is probably due to a lowering of pH of the cell-sap during ripening. The causes of the post-climacteric decline in ripening fruits likewise have been the subject of some controversy. Blackman and Parija believe this decrease in respiration to be due to starvation. Gustafson, on the other hand, concluded that in view of the fact that the percentage of total sugars in a ripe tomato is nearly twice that of a two-week-old fruit the final decrease in respiration cannot be due to starvation, but that "the decrease in respiration in the mature fruit might rather be attributed to complete cessation of all activity".

In the course of some biochemical studies on ripening of tomatoes the data obtained indicated that increasing amounts of CO_2 accumulate in the fruit tissue during ripening. Evidently in massive structures like ripe tomatoes the superficial tissues offer a great resistance to the movements of gases and the total CO_2 production during metabolism is not the same as that evolved at the surface. Two questions arise in this connection: (i) Is the climacteric rise in ripening tomatoes due solely to the establishment of a steep gradient between the concentration of CO_2 inside the fruit and that in the outside atmosphere, or (ii) Is it due to a lessened resistance of the superficial tissues to the diffusion of gases? In an attempt to get an answer to these questions the CO_2 dissolved in the fruit sap, respiratory quotient and the permeability of the superficial tissues to gas were determined at regular intervals during the stages of ripening and senescence.

Dissolved CO_2 was determined in accordance with the method described by Willaman and Brown[4] and for determining the permeability of superficial tissues to gas the apparatus used by Smith[5] for extracting gas from potato tubers was employed. Eight tomatoes, approximately alike in size and shape, were selected for each determination, the gas being collected in a gas burette after two minutes' extraction in a Torricellian vacuum. Relevant data are tabulated below:

Colour of the fruit	CO_2 liberated ml. kilo/hr.	Dissolved CO_2 ml. per kilo	Gas extracted from 8 tomatoes, ml.	R. Q.
Green ..	17·7	19·7	3·31	1·11
,, ..	19·3	20·3	3·36	1·08
Yellow green ..	20·3	20·1	3·79	1·07
,, ,, ..	26·7	21·7	3·85	1·01
Green orange ..	30·3	26·2	3·98	1·00
,, ,, ..	29·2	27·1	3·73	0·99
Orange red ..	27·3	30·6	3·01	1·01
,, ,, ..	20·7	33·3	2·87	1·23
Red ..	13·9	37·9	2·72	1·27
,, ..	11·7	37·1	2·46	1·29

An examination of the data shows that considerable amounts of CO_2 accumulate in the fruit tissue during ripening and that the R. Q. starts with a value somewhat higher than unity, comes down to unity during the climacteric phase and again rises gradually to 1·29. The value for the amount of gas extracted from the fruits gradually rises with the increase in rate of respiration up to the time when the peak value characteristic of the climacteric stage is obtained, after which a rapid decline is discernible. Evidently during the climacteric stage the resistance offered by the superficial tissues to the movement of gases—CO_2 outwards and atmospheric gases inwards—is lessened, thus augmenting not only the rate of CO_2 production but also that of oxygen intake. The suggestion is made that the climacteric rise in tomatoes, is in all probability, in part due to the establishment of a steep gradient of CO_2 concentration as also to an increase in the permeability of the superficial tissues to the diffusion of gases.

Another point which emerges from this investigation is that whereas the superficial CO_2 evolution declines after the climacteric, the dissolved CO_2 in the fruit tissue progressively increases. This increase in the concentration of CO_2 indicates an active rate of metabolism even in the post-climacteric phase. The decline in the respiration rate following the climacteric rise is probably explainable on the basis of a lowered permeability of the superficial tissues to the

diffusion of gases. On the basis of this it might be inferred as indeed it has been suggested by several investigators—that the actual concentrations of gases present within the plant organs, together with the gradients of gaseous concentration created in conjunction with the external atmosphere as well as the permeability of the superficial tissues to the diffusion of gases, are important in determining the rate at which CO_2 will be liberated from the surface under various circumstances. Evidently this disparity—between the metabolic production and superficial evolution of CO_2—is likely to introduce serious complications in the measurement of plant respiration by the usual methods.

B. N. SINGH.
P. B. MATHUR.

Institute of Agricultural Research,
Benares Hindu University,
May 14, 1936.

[1] Blackman and Parija, *Proc. Roy. Soc.*, (London), 1928, **103 B**, 412.
[2] Kidd and West, *Ibid.*, 1930, **106**, 93.
[3] Gustafson, *Plant Physiol.*, 1929, **4**, 349.
[4] Willaman and Brown, *Ibid.*, 1930, **5**, 535.
[5] Smith, *Hilgardia*, 1929, **4**, 273.

Some New Aspects of Nitrogen Fixation in the Soil.

IT has already been shown[1] that in presence of the mixed flora of the soil, non-symbiotic fixation of atmospheric nitrogen takes place largely after the added carbohydrate is used up. Evidence has also been adduced to show that the residual organic matter, consisting chiefly of volatile fatty acids and their salts, are utilised in the fixation.

Subsequent studies[2] have shown that if the initial fermentation is conducted outside the field and under conditions of restricted air supply, there is very little loss of carbon. It has also been found that if the products of fermentation are neutralised and applied to the soil in the form of their mixed calcium salts, then there is greater return of fixed nitrogen for the carbon utilised than would otherwise be the case. The following (Table I) will illustrate the type of results obtained :—

TABLE I.

Time in days	Organic carbon (in mg.) in 100 c.c. medium		Nitrogen fixed (in mg.) in 100 c.c. medium (Experimental-Control)	Ratio of nitrogen fixed to carbon utilised
	Control*	Experimental†		
0	28·4	48·7	Nil	..
4	..	38·1	0·77	..
8	28·0	34·8	0·80	1 : 17·4
12	24·0	31·6	0·83	1 : 20·6

* Ashby's liquid medium without sugar.

† Ashby's liquid medium + the concentrate of the products of fermentation to correspond to 20 mg. of organic carbon.

These observations have been confirmed by direct experiments with soils (Table II).

TABLE II.

Time in days	Organic carbon (in mg.)		Nitrogen fixed (in mg.) (Experiment-Control)	Ratio of nitrogen fixed to carbon utilised
	Soil (10 g.) 20 mg. equivalent of mixed calcium salts	Carbon utilised		
	*Bangalore Soil.**			
0	70·5	Nil	Nil	..
4	65·1	5·4	0.32	1 : 16·9
12	61·8	9·9	0·88	1 : 11·3
17	58·2	12·3	0·93	1 : 13·2
	*Kalar Soil (Sindh).**			
0	69·0	Nil	Nil	..
4	66·3	3·6	0.50	1 : 7·2
8	62·3	7·6	0·66	1 : 11·5
12	57·1	12·8	..	..
17	54·7	15·2	0·91	1 : 16·7

* In both the cases, the untreated soil did not show any appreciable variation in organic carbon, so the corresponding figures have not been recorded.

It has already been shown that if the carbohydrate is applied directly to the soil then the return of fixed nitrogen for the carbon used up will be of the order of 1 to 60 (Bhaskaran and Subrahmanyan, *loc. cit.*). The above results, representing nearly four times that efficiency, should be regarded

as a distinct advance on any of the results so far obtained.

In addition to the acids, the products of fermentation include other forms of organic matter, as also considerable quantities of mineral salts (chiefly iron, aluminium and manganese), in solution. Further work is in progress to determine as to how far these constituents (collectively or individually) contribute to the fixation. Attempts are also being made to prepare the mixed products in solid form and to standardise the conditions for their application in field practice.

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Department of Biochemistry,
Indian Institute of Science,
Bangalore,
July 21, 1936.

[1] Bhaskaran, T. R., and Subrahmanyan, V., *Curr. Sci.*, 1935, **4**, 234; *Proc. Ind. Acad. Sci.*, 1936, **3B**, 143.

[2] Bhaskaran, T. R., *Proc. Ind. Acad. Sci.*, 1936, **3B**, 320.

The Electrical Resistance of Wood and its Variation with Moisture Content.

THE electrical resistance of wood has been the subject of study by a number of investigators. Hasselblatt[1] and Stamm[2] noticed a linear relationship between the logarithm of the electrical resistance of wood and the moisture content below the "fibre saturation point". On the other hand, Suits and Dunlap[3] found that the degree of linearity is not so great as that observed by Hasselblatt and Stamm. The same is suggested by the experiments of Gaitzsch.[4] Stamm comes to the conclusion that the electrical resistance does not show any appreciable variation with species and density and that the steep logarithmic relationship established permits considerable variation in the resistance without largely affecting the calculated moisture content. Based on these findings a number of electrical moisture meters have been put on the market in Europe and America for the determination of the moisture content of wood between 7 and 24%.

Recently, in response to an enquiry the author had to design a cheap and reliable moisture meter suitable for this country. While the data mentioned above relate to American and European woods no data are available for Indian woods. In view of this fact and as the electrical resistance of wood has not been studied exhaustively under a variety of conditions a detailed investigation of the electrical resistance of Indian woods has been taken up by the author. In Fig. 1, some of the preliminary results obtained by the author are shown,

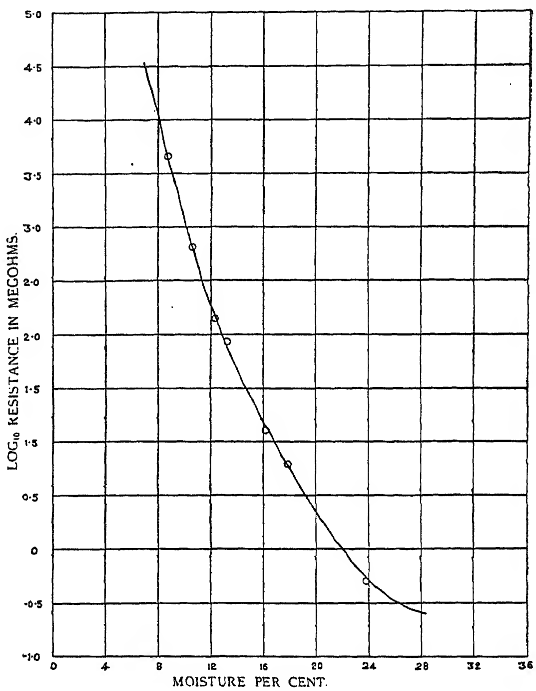

Fig. 1.

the logarithm of the resistance being plotted against the moisture content. They relate to small specimens of *Canarium euphyllum* (white dhup) which had been carefully conditioned in air-conditioning chambers[5] and hence were practically free from moisture gradients. The density of the pieces (based on oven-dry weight and oven-dry volume) varied from 0·333 to 0·484 gm./cm³. The results were obtained with a special type of knife-shaped needle contacts (which penetrate better into the Indian hard wood than the usual round ones) $\frac{3}{4}$ inch apart and a suitably designed thermionic vacuum tube amplifier. These results show that the degree of linearity is probably not so great as that observed by Stamm and the curve is more similar to that obtained by Suits and Dunlap. In Fig. 2, the same results are plotted on a logarithmic scale. The results of Suits and Dunlap have also

been plotted for the sake of comparison. While Fig. 2 suggests that there is an approximately linear relationship between the logarithm of the resistance and the logarithm of the moisture content it is

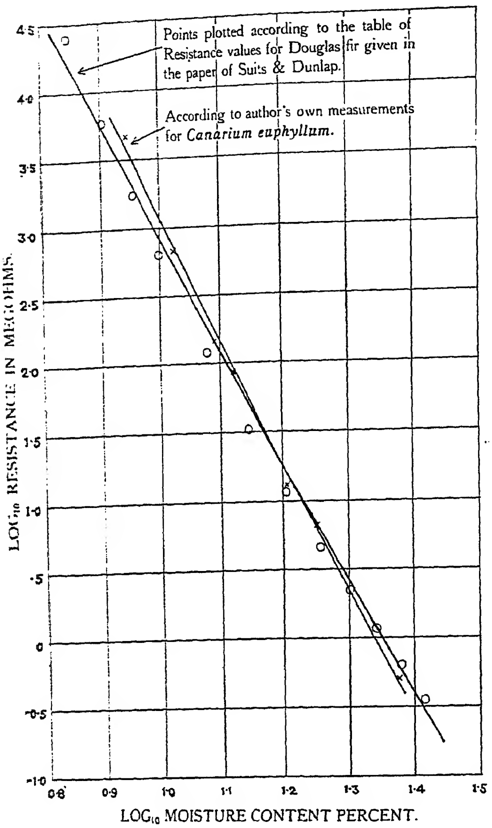

Fig. 2.

proposed to extend the study to specimens from different localities and of different density, species, etc. before arriving at any definite generalisations. In these preliminary trials it was also noticed that not inconsiderable variations exist in the electrical resistance of different species. For instance, *Bombax malabaricum* (semul) was found to have a considerably lower resistance while some woods showed a rather high value. The effect of species, density, temperature, steaming, removal of inorganic impurities, resin content, presence of drying or absorbing gradients, etc., will be studied.

A few vacuum tube circuits, including one employing a ballistic galvanometer have been studied and found satisfactory. Based on the results obtained so far, a moisture meter has been constructed which will shortly be tried in the wood-working industry. A detailed account of the work will be published in due course.

The author's thanks are due to Dr. S. N. Kapur, Officer-in-Charge, Seasoning Section, for his kind interest in the work.

D. Narayanamurti.

Seasoning Laboratory,
Forest Research Institute,
Dehra Dun,
July 29, 1936.

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1 *Z. anorg. und. allge. Chem.*, 1926, **154**, 375.
2 *J. Ind. Eng. Chem.*, 1927, **19**, 1021.
3 *Gen. Elec. Rev.*, 1931, 706–713.
4 *Forschungsberichte Holz* Heft **3**, 6.
5 *Vide* This *Journal*, 1934, **2**, 483.

A Clay Seal and a Sealing of the Śuṅga Period from the Khokra Kot Mound. (Rohtak).

Among the further material I collected on May 10, 1936, at Rohtak[1] was a well-preserved clay seal of square shape (Fig. 1) and a round sealing in Brāhmī characters (Fig. 5). As my full account of the antiquities from Rohtak is likely to be delayed in publication I propose to give here a brief description of these interesting specimens. Both the originals have been examined by Mr. K. P. Jayaswal who has kindly sent me notes on them.

1. The square seal, shown natural size in Fig. 1, may be disposed of at once. It bears three parallel lines in negative relief. The lines are in the form of a deep arc; they seem to have been made in one stroke, with a three-pronged instrument which was pushed obliquely into the soft clay at the commencement of the process. The significance of the sign is not clear. Mr. Jayaswal suggests that there was probably a *ga* (ग) in the middle of the arc, but I am unable to find a trace of any lines apart from the three seen in the photograph. Possibly they represent three *ga*'s, inside one another, but the positive (Fig. 2) seems to discredit this view. The seal was a surface find, from the hillock in the NE part of the mound, where there is a recently built shelter and a number of recent Hindu monuments to the

dead. Size 28 × 28 mm.; 10 mm. thick; the reverse is flat, and blank.

2. The round sealing, also in baked clay (Figs. 3–6), is of special interest, being the first seal in Sanskrit so far discovered from the pre-Christian era. All the others till now recovered from this era are in Prakrit. Mr. Jayaswal's reading is

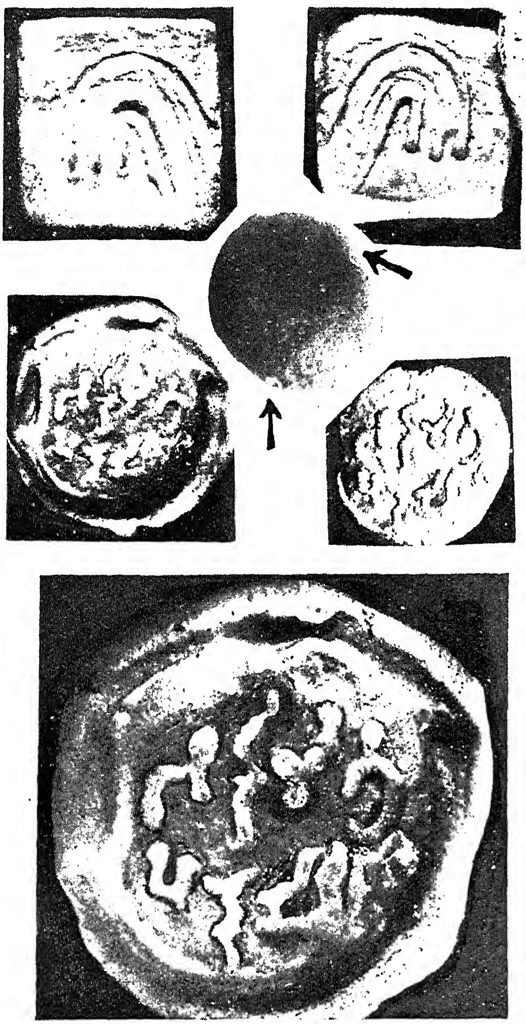

Fig. 1.

भद्रमित्र-	*Bhadramitra* (left to right).
स्य द्रोणीघाटे	*-sya Droṇighāte* (left to right).

He gives the date as 200 B. C. The seal belongs to the early Śuṅgas, whose names often ended in *-mitra*. The obverse is flat, with the Brāhmī characters in the positive. The reverse is smooth and convex, and it shows two perforations (indicated by arrows in Fig. 3), where a string was probably attached to fix the sealing to an article (possibly a document) sent to Rohtak. Mr. Jayaswal writes: "Evidently the owner was the officer-in-charge of the pass over the Droṇī (valley), Hindi Dūn, (which must have been in the Sivaliks, probably identical with Dehra Dun)." Size 24 × 26 mm. Find-spot, as for the seal above described; both were surface finds, lying near each other.

The positive impressions shown in Figs. 2, 4 and 6 were made in plasticine. That in Fig. 2 was made directly from the seal; the other one (Fig. 4, enlarged two diameters in Fig. 6) was made from a negative, which was first prepared from the original clay sealing. The plasticine negative was dusted with fine white powder (toilet powder does quite well); the surplus was then blown off lightly, leaving traces in the depressions. Then a positive was made; the letters thus come out white against a dark background.

In conclusion I wish to thank Mr. Jayaswal, as before, for his invaluable help. The photographs were kindly made at my request by Messrs. K. N. Kaul and H. S. Rao.

B. SAHNI.

Lucknow,
August 5, 1936.

[1] Sahni, "Antiquities from the Khokra Kot Mound at Rohtak in the Jumna Valley," *Curr. Sci.*, 1936, **4**, 796–801; see postscript, p. 801.

Germination of the Seeds of *Carica papaya* inside the Fruit.

THE occurrence of teratological phenomena in the cultivated varieties of *Carica papaya* seems to have attracted some attention. O. Penzig in *Pflanzen Teratologie* mentioned certain anomalies in the fruit of *Carica papaya* including the development of carpels with ovules and stigma inside the fruit which often gave rise to extra internal fruits. In the April issue of *Current Science*,[1] Messrs. Sayeeduddin and Bari recorded a case of internal proliferation in *Carica papaya*. A. P. de Candolle,[2] mentioned that instances of internal germination in the fruits of certain Cucurbitaceæ were not uncommon, and that Wydler had

observed in the West Indies a case of the germination of the seeds inside the unopened fruit of *Carica papaya*.

While stationed in Port Blair in April 1933, an instance of germinating seeds inside the fruit of *Carica papaya* came to my notice while cutting, a small fruit, about 5″ long and 4″ diameter. A large majority of the seeds inside were found in various stages of advanced germination. The accompanying photograph of a slice of the fruit (in preservation) shows the germinating seeds *in situ*. The seeds have a long slender plumule ending in 2 or 3 minute leaves, and the rootlets from the radicle showing through the transparent seed-coat, and in some cases projecting outside. The cotyledons are, in all seeds, still partially inside. In the photograph (Fig. 1), the seed on the top

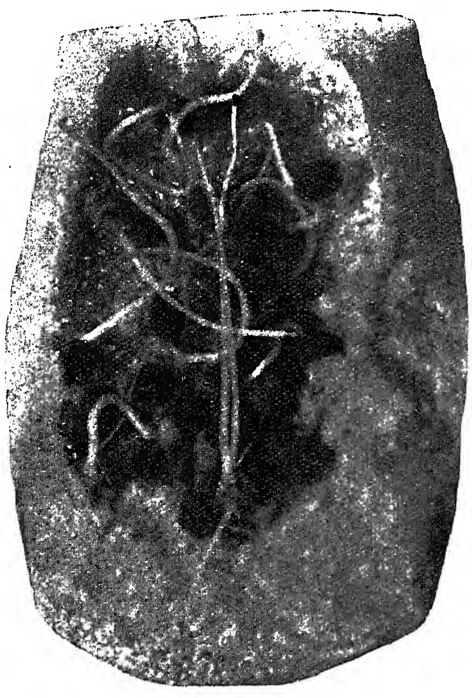

Fig. 1.

Photograph (natural size) of a slice of the fruit of *Carica papaya* showing the germinated seeds *in situ*.

left-hand corner has its plumule bent on itself and its cotyledons completely inside. In several other seeds dissected, the cotyledons are found inside the seed, and the extremity of the plumule bears the minute central leaves and a scar on each side left by the broken end of each of the cotyledons. In the rough sketch (Fig. 2) given here, the various structures of the germinated seed from inside the fruit are shown clearly.

It may be mentioned that the fruit was just ripe and somewhat insipid to the taste.

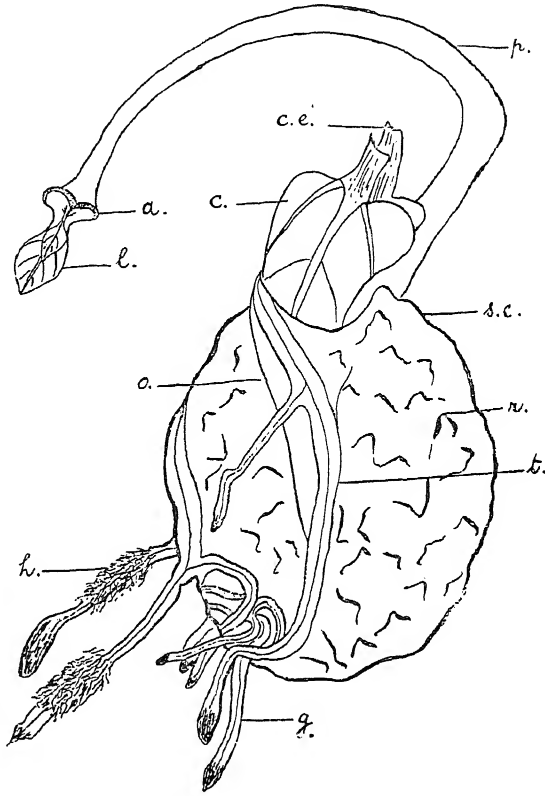

Fig. 2.

The germinating seed of *Carica papaya* showing the plumule, the cotyledons still partially lodged inside the seed and the roots, both inside and outside, the seed-coat.

a.—scar left by the stalk of the cotyledons.
c.—cotyledons.
c. e.—cut-end of the stalk of the cotyledons.
g.—growing branch roots from the radicle which have burst through the seed-coat.
h.—root-hairs.
l.—leaves.
o.—line along which the seed has been split by the growing radicle and plumule.
p.—plumule.
r.—rugosities on the surface of the seed showing through the transparent seed-coat.
s. c.—seed-coat.
t.—branch-roots of the radicle within the seed-coat.

I have to thank my friend Mr. T. D. Srinivasan for references on Plant Teratology.

H. SRINIVASA RAO.

Zoological Survey of India,
Calcutta,
July 22, 1936.

[1] *Curr. Sci.*, 1936, **4**, 740.

[2] *Physiologie Vegetale*, 1832, **10**, 653.

More Unrecorded Hosts of *Loranthus longiflorus* Desr.

In a previous communication[1] we mentioned a few unrecorded hosts of *Loranthus longiflorus* and dealt in some detail on the dispersal of seeds in this parasite. Recently Lacy[2] has given a list of a few more hosts which he has recorded from Patna. The following hosts of *Loranthus longiflorus* to our knowledge have not so far been recorded.

1. *Achras sapota* Linn.; 2. *Sapindus laurifolius* Vahl.; 3. *Acacia concinna* DC.; 4. *Calotropis gigantea* Br.; 5. *Murraya Koenigii* Shreng.; 6. *Eugenia jambos* Linn.; 7. *Eriodendron anfractuosum* DC.

It is a new invasion of this parasite on the above plants at least in Hyderabad. The invasion on *Achras sapota* and on *Eugenia jambos* is particularly threatening, and unless proper care is taken, these important fruit-plants are sure to suffer a good deal more than most of the other hardy trees on which *Loranthus* is parasitic.

It is as well to give here a full list of the host-plants so far found to be infected with this parasite in Hyderabad. This will prove useful to the workers on this problem in different parts of our country, and to those interested abroad.

1. *Psidium Guyava* Linn. (Myrtaceæ);
2. *Azadirachta indica* A. Juss. (Meliaceæ);
3. *Cordia Myxa* Raem & Sch. (Boraginaceæ);
4. *Anona Squamosa* Linn. (Anonaceæ);
5. *Punica Granatum* Linn. (Lythraceæ);
6. *Tamarindus indica* Linn. (Leguminosæ);
7. *Citrus Aurantium* Linn. (Rutaceæ);
8. *Millingtonia hortensis* Linn. (Bignoniaceæ);
9. *Morus indica* Linn. (Moraceæ);
10. *Dalbergia Sisso* Roxb. (Leguminosæ);
11. *Achras sapota* Linn. (Sapotaceæ);
12. *Sapindus laurifolius* Vahl. (Sapindaceæ);
13. *Acacia concinna* DC. (Leguminosæ);
14. *Calotropis gigantea* Br. (Asclepiadaceæ);
15. *Murraya Koenigii* Spreng. (Rutaceæ);
16. *Eugenia jambos* Linn. (Myrtaceæ);
17. *Eriodendron anfractuosum* DC. (Malvaceæ).

This list shows that *Loranthus longiflorus* is parasitic in Hyderabad on 2 members of the Myrtaceæ, 1 of Meliaceæ, 1 of Boraginaceæ, 1 of Anonaceæ, 1 of Lythraceæ, 3 of Leguminosæ, 2 of Rutaceæ, 1 of Bignoniaceæ, 1 of Moraceæ, 1 of Sapotaceæ, 1 of Sapindaceæ, 1 of Asclepiadaceæ, and 1 of Malvaceæ. It is evident, therefore, how cosmopolitan this parasite is. The danger threatening most of our economic plants cannot be over-estimated.

M. SAYEEDUDDIN.
M. A. WAHEED.

Botany Department,
Osmania University,
Hyderabad (Deccan),
July, 1936.

[1] Sayeeduddin, M., and Salam, M.A., *Curr. Sci.*, 1935, **4**, 106.

[2] Lacy, R. C., *Curr. Sci.*, 1936, **4**, 875 and 876.

REVIEWS.

India's Mineral Wealth. By J. Coggin Brown, O.B.E., D.Sc. (Oxford University Press, London; Printed in India at the Wesleyan Mission Press, Mysore), 1936. Pp. x + 335. Price Rs. 10.

The introduction of modern mining methods, the setting up of local metallurgical practices, and the rapid opening up of the country facilitating quicker and cheaper means of transport, have given to many of the mineral deposits of India, a greater commercial value than what could have been foreseen a few decades back. Moreover, the almost daily discovery of new and additional uses for several of the minerals, in various arts and industries are bound to generally enhance their economic importance. Under the circumstances it is necessary for those who are interested in the development of India's mineral industries to be posted with the latest information on the several aspects of her mineral assets. The requisite information is, no doubt, furnished by the Geological Survey of India through its periodic publications :—the occasional monographs on some of the economic minerals, the quinquennial reviews of mineral production, and the economic inquiries as contained in the annual "Records". But, as publications of a technical institution they may fail to catch the eye of the ordinary laymen. Therefore, Dr. Coggin Brown who was till recently on the staff of the G. S. I., as a Superintendent, has really rendered a useful service to the public in bringing out as a popular edition his *India's Mineral Wealth*, which forms an enlarged and rewritten version of the book which was first published in 1923.

In the present handy volume comprising of some 320 pages of text material, Dr. Coggin Brown has put together all the essential and necessary details concerning the mode of origin, occurrence, distribution, history of development, uses, production and other particulars on the Indian minerals in an easily intelligible style.

The mineral deposits of India, Burma and Assam have been primarily grouped into several allied sections and their detailed accounts have been constituted into four major divisions or parts.

Part I deals, in detail, with the mineral fuels—coal, lignite, petroleum and natural gas. All the known deposits of coal as contained in the several rock formations of India, the various oil fields of Assam, Burma and the Punjab, and the occurrences of natural gas, including the recent finds in Kathiawar and Baroda, have been described.

Part II, gives an account of the various metals and metalliferous ores. Gold claims our attention first as it ranks only next to coal among the major mineral industries of India. The various occurrences of this precious metal—in Southern India, in Chhota Nagpur and in other parts, have been noted and a brief description of the well-known Kolar Gold Field, is also given. One would have liked to see here a brief account of the method of extraction of gold as practiced in these mines. The remaining pages of this part, deal with the ores of iron, manganese, chromium, copper, lead and zinc and those of the semi-metals arsenic, antimony and bismuth. The author presages a great future for the Indian iron and steel industry.

Part III, constitutes descriptions of minerals used in various industries, such as,—materials useful for structural purposes; refractory, ceramic, and glass making material; mineral pigments, abrasives; and minerals used for agricultural purposes and chemical industries.

Part IV, forms a description of the known occurrences of the several varieties of gems and semi-precious stones of India and Burma.

The book contains numerous statistical tables and several graphs which indicate, at a glance, the fluctuation, of production of different minerals, from year to year. Small-scale maps showing the distribution of coal fields in India, oil fields in Assam and Burma, and certain other important mineral-bearing areas in India enhance the usefulness of the book and the inclusion of a few half-tone blocks of well chosen photographic views makes it attractive. The book is nicely printed.

It would have been better if the author had appended a tabular statement of a classified list of the main Indian Rock Formations without which pieces of information on the origin of rock types like Gondites

and Kodurites, etc., would be perplexing to those unfamiliar with Indian geological nomenclature.

There are many typographic errors, specially regarding the spelling of proper names, a few of which are noted below :—

Page 90, para 4, line 3, 'Ingladhai' should be 'Ingladhal'; Page 197, para 4, line 8, 'Matrod,' should be 'Mattod'; Page 137, para 2, line 4, 'Nuggihali,' should be 'Nuggihalli'; Page 313, 'Krishnachair,' should be 'Krishnachar'.

When dealing with the occurrences of minerals in Mysore, the author seems to have failed to carefully refer to the published papers of the State Geological Department and consequently many avoidable errors have crept in, specially regarding the correct location of places mentioned.

These are only some of the minor errors which can be rectified in the subsequent editions of the book, and they do not in any way discount its usefulness to the class of readers who desire to get a full and reliable information on the Mineral Wealth of India.

B. RAMA RAO.

Practical Photo-micrography. By J. E. Barnard, F.R.S., and F. V. Welsch. Third Edition. (Edward Arnold & Co., London), 1936. Pp. 352. 21*s*. net.

Photo-micrography has advanced so much since the publication of the second edition of the above book in 1925 that the publication of a third edition was overdue. In this edition the book has been rewritten and enlarged so that much that is unnecessary is eliminated and the more recent advances in photo-micrography have been added. As the authors point out in the introduction photo-micrography embraces a wide and varied field of work such as, metallurgy, petrology, biology, etc., so that the book has to cater to a variety of tastes. To users of the microscope in one branch of science the wealth of detail and elaborate description of apparatus to be found in the book may appear superfluous but it may be welcomed heartily by others. The book under review will be found useful both by specialists and by those who have no experience in photo-micrography and want to gain the necessary preliminary knowledge. A study of the book will go a long way towards minimising the number of photographic plates and the time that a tyro generally wastes in trying to get good results.

In the earlier chapters are given descriptions of various microscopes, photo-micrographic outfits and necessary optical equipments. The next chapters deal with their adjustments and manipulations. Towards the end a full chapter is devoted to photomicrography by ultra-violet light. Photomicrography by infra-red light is included in a chapter on special processes which also contains a description of apparatus for micro-metallurgy. The numerous plates at the end of the book speak for themselves in showing how extraordinarily clear microphotographs with an enormous wealth of detail can be obtained by following the methods outlined by the authors. While recommending the book to users of the microscope, one cannot help feeling that it would have been much more useful if some of the processes in Chapter XI had been treated in slightly greater detail. It is sure to be welcomed as a book of reference and a guide for buying apparatus in all laboratories where microscopes are used.

S. R. S.

Physical Chemistry for Colleges: A Course of Instruction Based upon the Fundamental Laws of Chemistry. By E. B. Millard. (McGraw-Hill Publishing Company, Ltd., London), 1936. Fourth Edition. Pp. 524. Price 21*s*.

The subject-matter is treated in the following sequence:

Introduction; Determination of Atomic Weights; Properties of Substances in the Gaseous State; Properties of Substances in the Liquid State; Solid Substances; Solutions; Solutions of Ionized Solutes; Thermochemistry; Equilibrium in Homogeneous Systems; Heterogeneous Equilibrium; Kinetics of Reaction; Radiation and Chemical Change; Periodic Law of the Elements; Radioactive Changes; Atomic Structure; Colloids; Surface Chemistry; Free Energy of Chemical Changes; Electrochemistry.

In recent years the majority of textbooks on physical chemistry written in English have come from American authors. The author states "Since this book is addressed to students in the third or fourth year of college, it makes no pretence to 'cover' physical chemistry.......He has attempted to provide, in a form suited to

the capacity of college students, the groundwork for the more important aspects of his subject." The presentation of the material in such text-books is largely a matter of the individual experience and outlook of the author. The present tendency is to emphasise the requirements and the point of view of the students who have to learn so much within a limited period of time. Too much attention cannot and should not be paid to detailed treatment of theories or to deductive and inductive reasoning. A lucid presentation of the important facts, experimental methods, quantitative relationships and an outline of the basic theoretical concepts in their relation to the facts and data discussed in the text therefore form the main objective. A point of importance is the extent to which the student has been encouraged and urged to consult standard data and to use them. It is a pleasing feature of the book that such a wealth of material has been dealt with in 512 pages satisfying the requirements stated above. The questions at the end of each chapter have been carefully chosen to supplement the data given in the text.

The danger of such methods of approach lies in the student not realising the limitations, or, the approximate nature of the equations, or, the implications of bland statements of theories put before him. Where large number of references are given to original papers the beginner runs the risk of giving undue weight to them as he has not yet the requisite knowledge to exercise a critical judgment. Evidently there must be a compromise between the rival claims of the necessity to acquaint the student with basic facts and data and to enable him to use them and of the necessity to acquaint him with the fundamental theoretical premises and reasoning. A reference to the discussions on the applications of the kinetic theory of gases and on the activity concept will serve to illustrate the manner in which this compromise has been faced by the author. The reviewer is inclined to think that the compromise has been to the disadvantage of the theoretical background. This remark does not detract from the merit of the book which should be found very useful by both Pass and Honours students in chemistry, of Indian Universities.

J. N. M.

The Story of the Plant Kingdom. By Merle O. Coulter. (University of Chicago Press, Chicago), 1935. Pp. 270. \$2·5.

It can be said without fear of contradiction that the average person knows very little about science and usually dislikes being bored with it. Part of the reason lies with scientists themselves. Those who are really well-fitted to write a readable text for such an audience are usually too busy with their "own work" and have no aptitude for writing elementary treatises. Others, who do make such attempts, are often too raw to discharge this duty satisfactorily.

The work under review has been designed as a first book in Botany for the new course of general instruction provided by the University of Chicago for the Freshman and Sophomore years and the author is to be congratulated for presenting the subject in such a lucid and interesting manner. Readers' faces will surely brighten up when they run across sentences like the following, which abound in the book:—"Many a housewife, planning to salvage the remainder of a three-year-old loaf, has been distressed to find parts of it covered with fine white 'whiskers'. In fact, most of us have doubtless eaten bread in this condition without realising that we are getting more than we had bargained for," (pp. 46–47). Again, of the inability of the green plant to use the nitrogen of the air, he says (p. 187): "This limitless supply of nitrogen is of no more value to the green plant than is sea-water to the thirsty, shipwrecked sailor."

There are copious footnotes, which serve to clear up some deliberate simplifications made in the text or provide additional interesting information. Usually they have the weight of authority, but now and then one stumbles across statements which need to be modified even in an elementary book like this. One might, for instance, object to the use of the word "*all*" in the footnote on p. 219, where it is written that "as far as the writer knows" there is a triple fusion in all angiosperms. Many exceptions are now on record, and there are one or two entire families of angiosperms where this is an irregularity rather than the rule.

The printing and general get-up of the book are excellent, but one must remark that some of the illustrations are amateurish and the claim that they "were drawn to resemble as closely as possible the actual

laboratory specimens" seems somewhat high-sounding.

P. MAHESHWARI.

The Plant Kingdom: A Text-Book of General Botany. By William H. Brown. (Ginn and Company, Boston), 1935. Pp. 869, 1040 figs. Price 15*s.* net.

Teachers of Botany have reason to feel gratified, for, within the past five years several really good texts in the field have been published. Those who have used Prof. Brown's earlier book (1925) will welcome the appearance of this one. Most of the other books deal with plants of temperate regions. This deals with plants of the tropics and is therefore suitable for adoption in India.

The style of writing is simple and direct, the material is presented in an interesting fashion and the illustrations are among the best so far published in any text-book of Botany. A little less than half of the book is devoted to the structure and physiology of seed-plants and every one of the chapters is executed with exceeding care and thoroughness. The second part of the book is a general survey of the whole plant kingdom. A large number of forms is described: the main types are treated in detail but enough is given of the intermediate ones to enable the student to get a true perspective of the evolution of the whole range. Modern discoveries are given due consideration and this is specially evident in the part dealing with the Thallophytes. Adequate space is allotted to fossils including even the Psilophytales and Caytoniales which have been discovered only in recent years.

The book is outstanding in the thoroughness with which Plant Morphology has been treated and the price is quite moderate considering the large number of illustrations, which are artistic as well as accurate.

P. MAHESHWARI.

A Text-Book of Mycology. By E. A. Bessey. With 139 illustrations. (P. Blakiston's Son & Co., I, Philadelphia), 1936. Pp. xv + 495. Price $4·00.

The work is designed to meet the need for a text-book that shall give to the would-be plant pathologist an idea of the structure, life-history and classification of the more important groups of parasitic fungi. The author states in his preface that no satisfactory text-book of mycology is available in the English language except that of Haumann and Dodge. He has apparently ignored such excellent books as Harshberger's and Gwynne-Vaughan and Barne's. In spite of the extensiveness of the citations in the bibliographies given at the end of each chapter and also at the end of the book, many of the important European and Indian publications are omitted. These omissions notwithstanding, this book is a very good introduction to the systematic study of fungi. Though the book is intended "for a first course in mycology varying from 12 weeks to a whole College year," the book is also suitable for students undergoing a two-year course in mycology.

The book is divided into XV chapters, the first being devoted to an introduction giving the definition, structure, physiology, parasitism and reproduction of fungi. A brief history of mycology is also given.

In the second chapter under the title of non-filamentous fungi, he has brought together such widely different groups as Mycetozoa, Acrasiales, Babyrinthulales, Plasmodiophorales and Chytridiales. A lot of controversial matter has been introduced in this chapter by removing the Chytridiales from the Phycomycetes and putting them along with Mycetozoa. For a student who just begins the study of mycology, the indefiniteness of this very first chapter after the introduction is likely to be confusing and misleading.

Chapters III, IV and V are devoted to the study of the Phycomycetes. In the classification of this class he has mainly followed Fitzpatric. He has departed from him in removing Chytridiales from this class and in placing Blastocladiaceæ in the order Monoblepharidales and Arcylistidaceæ in Saprolegneales. Anycylistales and Blastocladiales are not recognised as having status to form separate orders.

Chapter VI forms an introduction to the higher fungi.

Chapters VII, VIII and IX are devoted to the classification of the class Ascomyceteæ. These chapters are very useful as the classification is based on the latest literature available.

Chapter X deals with the rusts and smuts for which a separate class, the Teliosporeæ has been constituted. This is a very welcome feature of the book.

Chapters XI, XII and XIII deal with the classification of the Basidiomycetes.

Chapter XIV deals with the imperfect fungi and in this the author brings together

the result of investigations from an unpublished thesis by H. P. Bender.

The last chapter giving the literature for the identification of fungi is an extremely useful compilation and every student of mycology will commend the author for this admirable guide.

On the whole, the book is an excellent guide to the systematic study of fungi and individual families are abundantly illustrated containing a total of 139 well-selected figures, all of a high standard of excellence.

S. S.

The Fishes of the Indo-Australian Archipelago. By Prof. Max Weber and Prof. L. F. de Beaufort. Vol. VII. (Messrs. E. J. Brill, Leiden, Holland), 1936. Pp. xvi + 607, 106 figs.

Students of ichthyology interested in the fish-fauna of South-eastern Asia, comprising India, Ceylon, Burma, the Indo-Australian Archipelago, Siam, Indo-China and Southern China, are familiar with the monumental series of volumes in English under the joint authorship of two Dutch Savants, Professor Dr. Max Weber and Prof. Dr. L. F. de Beaufort, of the University of Amsterdam. New volumes in this series are eagerly awaited, as Drs. Weber and de Beaufort have very carefully sifted all the available evidence and have spared no pains in clearing up the synonomies, relationships and the precise limits of distribution of the very large number of families and genera of fishes found in this rich area by an examination of the original types in the various museums of Europe and a critical study of the extensive literature. Both the authors fortunately have considerable experience of field work in the area, during which period they observed in the living condition many of the fishes which they deal with in their monumental work.

The seventh volume of this work dealing with a part of *Perches perciformes* (families: Chætodontidæ, Toxotidæ, Monodactylidæ, Pempheridæ, Kyphosidæ, Lutjanidæ, Lobotidæ, Sparidæ, Nandidæ, Sciænidæ, Malacanthidæ, and Cepolidæ), has just been published. Some of these fishes live among corals, and in nature they are gorgeously coloured. Even the black and white illustrations reproduced in this volume are a delight to the eye. As the *Perciformes* are concluded in this volume an artificial key to its families occurring in the Indo-Australian Archipelago is given at the end of the systematic treatment. The keys to the genera under each family and to the species under each genus make it very easy to use this and the earlier volumes.

The get-up of the volume and the printing are excellent. The arrangement of the figures in the text makes them easily available for reference.

All the volumes are of a uniformly high standard and though they cannot absolutely replace Day's *Fishes of India* for the study of Indian fishes, they are equally indispensable for the correct and up-to-date determination of a great majority of the fishes of India. As there is a revival of interest by certain Universities of India in the study of fishes, Indian students should find Drs. Weber and de Beaufort's volumes of immense help. The contents of the first six volumes are as follows:—

1911. Vol. I. Index of the Ichthyological Papers of P. Bleeker.

1913. Vol. II. *Malacopterygii, Myctophoidea, Ostariophysi*: I. Siluroidea. 151 figs.

1916. Vol. III. *Ostariophysi*: II. Cyprinoidea, Apodes, Synbranchi. 214 figs.

1922. Vol. IV. *Heteromi, Solenichthyes, Synentognathi, Percesoces, Labyrinthici, Microcyprini*, 103 figs.

1929. Vol. V. *Anacanthini, Allotriognathi, Heterosomata, Berycomorphi, Percomorphi* (Families Kuhliidæ, Apogonidæ, Plesiopidæ, Pseudoplesiopidæ, Priacanthidæ, Centropomidæ), 98 figs.

1931. Vol. VI. *Perciformes*. (Families: Serranidæ, Theraponidæ, Sillayinidæ, Emmelichthyidæ, Bathyclupeidæ, Coryphænidæ, Carangidæ, Rachycentridæ, Pomatomidæ, Lactariidæ, Menidæ, Leiognathidæ, Mullidæ), 81 figs.

The senior author, Professor Weber, is now over 80 years of age, but age has in no way impaired his energies which from a very early age have been devoted to the cause of science. All students of fishes will join with the reviewer in wishing him many more years of health and happiness. May both of the authors live long to bring to a successful conclusion the work on the "Fishes of the Indo-Australian Archipelago" which will be an everlasting monument to their skill, energy and resourcefulness.

S. L. H.

A Study of the Soils in the Hill Areas of the Kulu Forest Division Punjab. Part I. (Indian Forest Records, Silviculture Series I, No. 2.) By E. McKenzie Taylor, I. D. Mahendru, M. L. Mehta and R. C. Hoon. (Manager of Publications, Delhi), 1936. Pp. 289–293. Price Rs. 2–2–0.

To say that we know almost next to nothing about Indian Forest Soils would be an exaggeration. But it would be the exaggeration of a truth. Any book dealing with our Forest Soils, therefore, is welcome as filling up a great void. But, it is a great pleasure to come across a publication as the one under review which, in the careful planning and the efficient execution of a study of the Kulu Forest Soils, may well serve as a pattern on which similar work elsewhere in India could be based.

The authors have made a careful study of representative profiles in the area with regard to their physical, chemical and surface vegetation properties. The normal monthly precipitation in the Kulu Valley is recorded and its bearing on the profile formation discussed. From these data, the authors classify the general profile type of the area to be related to podosols and indicate the suitability of the type to individual forest crops. A sketch map of the Kulu Forest Division and two colour plates illustrative of the Soil profiles are provided.

For the sake of comprehensiveness, a few suggestions may perhaps be made which the reviewer feels will make such a piece of research even more useful. The chemical analysis of the primary rocks from which the soils are derived, for example, would lead to a better appreciation of its weathering to the present profiles. In this connection, it must be observed that the data relating to the climatic factor are not complete. The authors, however, recognise this deficiency (p. 291) which, they say, was unavoidable. For example, if temperature records for the area were available, the "Rain Factor" of Lang (being the rainfall in mm. divided by the average temperature in degrees centigrade) could have been calculated and correlated to the Soil type. Again, the C/N ratios of the A_0 and A_1 profiles might have yielded valuable indication of the nature of the Humus.

The work of Dr. McKenzie Taylor and his colleagues has considerably enriched the scientific literature on Indian Forestry. It is to be hoped that many more such papers will emerge from their Institute.

EMMENNAR.

Bulletins of Indian Industrial Research. No. 1. Bibliography of Industrial Publications. (Published in India from 1934.) Pp. 257. Price Rs. 4–6–0; **No. 2. A Survey of the Indian Glass Industry.** By E. Dixon. Pp. ix + 39. Price As. 14. (Manager of Publications, Delhi), 1936.

The first number of the *Bulletin of Indian Industrial Research* published under the auspices of the Industrial Research Bureau is, appropriately enough, a Bibliography of Industrial Publications published in India from 1921. The publication is divided into three parts. In the first part, the papers are arranged according to publishing authorities which include Government Departments in British India and in Indian States; Institutions like the Indian Chemical Society, the Indian Institute of Science, etc.; and important journals like *Current Science*. Part II is a bibliography according to subjects and is followed by Part III which consists of an alphabetical index. The list of publications is very comprehensive, including original papers, reports, bulletins, lectures, etc., and embracing even subjects which have only a remote bearing on industrial problems. The book will be found extremely useful by all those who contemplate starting a new industry or are engaged in industrial research, as it supplies, in a handy and attractive form, references to practically all important sources of information available on a wide variety of subjects.

The Indian Glass Industry.—Before formulating proposals to improve the glass industry in India, it was considered necessary by the Industrial Research Bureau to gather all facts concerning the present state of the industry in India. This publication gives a brief account of the main features of the industry in India such as (*a*) the chief centres of production, (*b*) elementary features of the processes employed, (*c*) raw materials and their choice, (*d*) statistics regarding local production as well as imports of chief types of glassware and (*e*) some economic aspects.

The descriptive accounts of processes such as bangle-making are clear and easy to follow and the nine plates and illustrations provided, are of great help to the reader. A consideration of the economic

aspects of the industry brings out the following points:

"(a) That the soda ash content of Indian glass is unnecessarily high and that the lime content is low resulting in glass of inferior quality.

(b) That the various costs for materials vary widely in different localities, being greatly influenced by railway freights, but that soda ash, weight for weight, is everywhere very much more costly than the other bulk materials.

(c) That in spite of this, the cost of the coal consumed is the heaviest of the charges for materials in the manufacture of ordinary white glass.

(d) That the fuel consumption is very high in relation to the quantities of glass melted."

This publication does not meet the requirements of the specialist but it serves admirably to bring before the average public the magnitude of the glass industry as well as the conditions which have impeded its progress in this country.

Scientific Reports of the Imperial Institute of Agricultural Research. Including the Reports of the Imperial Dairy Expert, Physiological Chemist and Sugarcane Expert, for 1933–34.) (Manager of Publications, Delhi), 1936. Pp. 213, Price Rs. 4–8.

These reports of the Research Institute relate to the year of the great Bihar earthquake which caused irreparable damage to the Institute and necessitated the abandonment of Pusa as one used to know it and its transference to the more central and spacious environs of New Delhi where its activities will cover an ampler field and have advantages in staff, equipment and the co-operation of the other officers of the Imperial Research Council such as the old Institute never possessed. The scope and methods will in all probability be reviewed and reinforced by the opinions of the experts who will soon be coming out to advise the Government on these matters, so that we may expect the new Institute to start work under the best auspices. Work during the year had naturally been much dislocated and for fully half the year had been carried on under great difficulties and on a restricted scale. The same circumstance probably accounts for the very great delay in the publication of this report.

Taking the various items of work recorded, an important conclusion confirming previous years' results is the enrichment of soils in nitrogen by the growing of legumes either as a mixed crop or in rotation with cereals to the extent of as much as over 415 lbs. per acre. The results are to be subjected to a statistical study to decide which among the two methods is the better one from the economic point of view. It should not be forgotten that practical considerations also favour the mixed cropping system, for mixtures are not confined to legumes but cover a wide variety of crops belonging to other orders as well; it is not a case therefore of mere enrichment in soil nitrogen. In regard to green manuring with sannhemp it is brought out that the tops of the sannhemp if ploughed in, increase the yield of wheat quite as much as the whole plants and the utilisation of the sannhemp therefore partly for fibre and partly for manure is recommended. The usefulness of Mexican sunflower for growing as green manure in a standing crop is indicated in experiments conducted with onions as the main crop. Considerable chemical work has related to studies of several types of soils, notably certain calcareous soils; perhaps work of this kind relating to all the different types of soils in India in all their aspects can be said to fall within the scope of an All-India or Federal Institute of this character to which attention may therefore be bestowed in a greater measure. The improvement of crops by breeding has continued to receive well-merited attention and the achievements of the past in regard to wheat and sugarcane promise to be kept up, if not excelled, with further work on these and other crops. Rust resistance in wheat occupies the pride of place among the objectives and some promising strains notably Pusa 101 have already been evolved. Much is also expected of certain strains of linseed combining high oil and high yielding capacity with resistance to linseed rust. The great work on sugarcane improvement is now being directed for the past few years to the thick canes and certain varieties evolved and distributed already have been found very satisfactory notably Co. 402, in which factories will find an exceptionally good cane of the late maturing type. More evidence is again forthcoming of the merits of the sugarcane sorghum hybrids, the juice in some of them reaching a purity of 85 per cent. in less than seven months and at their best being even superior to the other Coimbatore canes; some of these will before long be available for cultivation on a large scale. Several important plant diseases have continued to be studied and the conclusion that the virus causing

sugarcane mosaic is closely related to filtrable forms has been tentatively established. Seed disinfection against the various smuts, bunts and wilts, helminthosporiums, etc., has been tried with the new patent preparations like uspulum, and cerasan, though not with uniform success. The possibility of controlling the foot rot of the betal vine by means of the fungicides, Bordeaux mixture and "Kerol" has been established, which is quite a valuable practical conclusion. Among insect pests sugarcane pests have received much attention and in the case of the serious new pest Pyrilla the middle of June has been found to be the peak of infestation and egg laying. The pests and diseases attacking fruit orchards in British Baluchistan have been surveyed in the year. One would greatly wish for a very material expansion of these sections so that the pests and diseases which are only too numerous and against which the ryot is at present absolutely helpless may be more comprehensively studied and remedies found out. It is a most difficult task but its importance fully warrants and demands such expansion.

An interesting section is that of the Physiological Chemist whose work on the problems of nutrition and the value of the local feeds and fodders forms a most fruitful branch of research and of a kind falling eminently within the scope of a Federal Institute. The digestibility of coarse fodders continued to be studied and the fact of digestibility increasing with the protein content of the fodder established. Lucerne hay has been found not to suffer in chemical composition or digestibility as compared with the green material, the loss being only in the dry matter content. Molasses as a feed, the mineral composition of fodders at different stages of growth, comparison of high and low protein feeding, calcium and phosphorus content of the blood of cows and several other important items of work have been carried on. There is a great deal of local traditional knowledge relating to the qualities of the numerous grains, pulses and coarse fodders, both green and dry, which will well repay investigation alongside of the fundamental problems of nutrition. The field for really useful research here is vast and the present provision for research of this kind is meagre and the output necessarily inadequate to the needs of the situation. The allied branch of dairying appears to have got into a kind of routine. The milk yield of the cows in Pusa and at the different stations is stated to have considerably increased but nowhere is any evidence of the stations having materially influenced the industry or the quality of the cows on any part of the country to be seen. At the important Bangalore Station it is moreover a tale of epidemic and other diseases and heavy mortality in the herd. A new orientation of aims and policy with the necessary facilities for carrying them out appears to be called for if the section should materially benefit the dairy industry.

A. K. Y.

Tables of Standard Errors of Mendelian Ratios. By S. S. Purewal, M.Sc., Ph.D. and P. Krishna Rao, L.Ag. (Miscellaneous Bulletin No. 11 of the Imperial Council of Agricultural Research, Manager of Publications, Delhi), 1936. Pp. 37. Price As. 12.

At the present time, most of the biologists concerned with Mendelian ratios are familiar with the test of goodness of fit of observed ratios. The authors of these tables deserve thanks for providing this ready reference for those engaged in genetics.

There is a brief introductory note lucidly explaining the construction of the tables and their use. For values of n from 5 to 1,000, the tables present the standard error of expected numbers for the ratios 1 : 1, 3 : 1, 9 : 7, 15 : 1, 13 : 3, 27 : 37 and 63 : 1, and also the S. E. expressed in percentage for the 1 : 1 ratio which is expected to be of value in linkage studies. Instructions are given for extending n up to 100,000. The authors' standpoint, that a deviation from expectation must not exceed twice (1·95996 times) the S. E. for a good fit, is the same as the X^2 test for one degree of freedom on the $P = \cdot 05$ level of significance; X^2 is actually the square of deviation/S. E. However, the actual calculation of X^2 or the probable error, as some workers still do, involves a good deal of arithmetical calculation. Given the population and the expected ratio, the test is obtained at once from these tables.

The price of the book is modest for the labour involved. There is no doubt that geneticists will use this book constantly.

G. N. R.

Foundations for the Study of Engineering. By G. E. Hall, B.Sc. (The Technical Press, Ltd., London), 1936. Pp. vi + 259.

In this small book of about 250 pages.

the author has attempted to deal with the fundamentals of Statics, Dynamics, Mechanics of Fluids, Friction and Lubrication, Heat and Heat Engines. The book is well written and illustrated. The author has worked out numerous examples to illustrate the applications of the principles to concrete cases and has also included sets of examples to be worked by the students to familiarise themselves with the theory. The book treats only with very elementary portions of engineering, and hence it is suitable for schools where attempts are made to give the students an idea of engineering science. The book does not deal with principles of electricity and magnetism and hence the title should be *Foundations for the Study of Mechanical Engineering*. The author has dealt with the subject in a very concise but clear way, but at places he rather labours much to explain very small points like P − Q + Q = P. Some of his diagrams could have been better and also more accurate, as for example, the "Load Extension" diagram on page 107. The book may, with great advantage, be used in engineering schools. The publishers are to be congratulated on the neat get-up and printing of the book.

E. K. R.

Cinematique Du Solide Et Theorie Des Vecteurs. (Actualitiés Scientifiques et Industrielles, No. 325.) Par Ch. Platrica. (Herman et Cie., Paris), 1936. Pp. 54, Price 12 *fr*.

This tract is the first of a series of three elementary tracts on the Geometry preparatory to the study of Newtonian Mechanics. In the earlier pages, a summary of the main results of the elements of Vector Analysis is given; later, these are applied to the study of the most general displacements of a rigid body. As an illustration of the power and brevity of Vector Methods to the study of kinematics, the latter half of the book deserves careful perusal. This booklet will serve as a small but decent book of reference to those who are interested in Vector methods in kinematics.

M. V.

Les Theoremes de la Moyenne pour les polynomes. (Actualités Scientifiques et Industrielles, No. 302.) By J. Favard. (Herman et Cie., Paris), 1935. Pp. 50. Price 15 *fr*.

This monograph deals with the theorems on the location of roots of polynomials whose coefficients satisfy a linear relation. It is divided into two chapters, the first of which deals with the beautiful generalisation into the complex region of Rolle's theorem by Grace and allied generalisations and the second, with the relation between the existence of a real root of a polynomial whose coefficients satisfy a linear relation and the existence of a monotonic function whose Stieltjes moments are given. A good deal of what is contained in the book should be added to the syllabus of the honours courses of Indian universities, as the existing English text-books on the theory of equations contain practically nothing about this development. Grace's theorem is proved by a method utilising normal functions (the proof can obviously be modified to an elementary one) which does not of course give the precise value of the constant but is capable of generalisation. The precise constant is determined by a method analogous to the first beautiful proof of the theorem by Szego (see *e.g.*, Polya-Szego. *Aufgaben und Lehrsatze aus der Analyse*, Bd. II, Ab. V). The second chapter deals also with the approximation to a quadrature and a few generalisations of the preceding fundamental results. One would however wish that the author had written a book on a broader topic.

K. V. I.

Proprietes Generals de l' equation d' euler et de Gauss. (Actualités Scientifiques et Industrielles, No. 333.) By E. Goursat. (Herman et Cie., Paris), 1936. Pp. 92, Price 20 *fr*.

This book, divided into five chapters deals with the general properties of the hypergeometric function. As is the case with the other text-books of the author, the book is very simple to study and assumes only elementary knowledge of differential equations and the theory of functions on the part of the reader. The first chapter deals with the 24 solutions of Kummer, Riemann's generalised definition, etc. The second is devoted to the solution by quadratures; the third, to the reducible case. The fouth chapter introduces the reader into the important concept of the group of the equation (without assuming any acquaintance with the general theory of automorphic functions) and the solution of the problem, when two hypergeometric equations have isomorphic groups. The last chapter is devoted to the

linear relations between the integrals. The reader will find in the book all the general properties including the questions, *e.g.*, when a hypergeometric equation should possess a rational or an algebraic solution, etc. The study of the book gives a good deal more than what is usually contained in books on differential equations and forms an introduction to the classical treatise of Klein.

K. V. I.

Les Defenitions Modernes de la Dimension. (Actualités Scientifiques et Industrielles, No. 274.) By Bouligand. (Herman et Cie., Paris). Pp. 44. Price 12 *fr*.

This clearly written monograph is an excellent introduction to the modern theory of dimension, which can be read with profit before one reads the classical and comprehensive treatise of Menger. The author's exposition is extremely lucid. He does not assume much previous acquaintance with higher analysis. The book is divided into four chapters, the first one being historical introduction.

The last three chapters deal with the three fundamentally distinct definitions of dimension. The first one is the abstract definition of Frechet. The second is the inductive definition of Poincare whose modern precise definition is mainly due to the works of Brouwer, Lebesgue, Menger and Urysohm. The last one is based upon the idea of measure which is due to Hausdorf. It is a pity that the book does not contain the proofs; nevertheless it is a book which is interesting for a mathematician, a philosopher and a general reader.

K. V. I.

Series Lacunaires. (Actualités Scientifiques et Industrielles No. 305.) By Mandebrojt. (Herman et Cie, Paris.) Pp. 40. Price 12 *fr*.

This monograph deals with a special topic in the theory of functions of the complex variable, *viz.*, the influence of gaps in the taylor-development of the function on the singularities on the circle of convergence. The earliest of such a series is that of Weierstrass whose example was followed by beautiful gap theorem of Hadamard. This book deals with the recent generalisations many of which are due to the author himself; the results are extended to the case of Dirichlet's series and integral functions. (Instead of singular points, direction of Julia come instead.) As the book is small the proofs are naturally given only in outline; but a good learner can complete the proofs by following the outline. The author does not claim the book to be a comprehensive treatise on the subject and as such it does not contain many other allied topics such as Ostrowski's over-convergence theorems, etc.

As the subject has been developed a great deal in recent years, the usual representation of this topic in text-books on theory of functions (*e.g.*, Biebubach—*Lehrbuch der Funktionero-theorie* II, second edition 1931, and Dienes-Taylor series) has become out of date. This book therefore supplies a long-felt want among learners and teachers of the subject. One would however wish that the book was more comprehensive in its outlook.

K. V. I.

Lecons de Metrologie : I. Généralités sur Les Mesures; II. Mesures Géométriques; (Nos. 236 and 278 of Actualités Scientifiques et Industrielles). By Pierre Fleury. (Hermann et Cie, Paris), 1935. Pp. I—73 and II—108. Price I—15 *fr*. II—20 *fr*.

These two brochures form part of a course on Metrology given by the author at the Conservatoire National des Arts et Métiers. Five more fascicules are to appear dealing with other branches of Metrology. The first part deals with the definition and realisation of standards, experimental procedure, determination of the limits of precision and the theory of errors, graphical representation, numerical work and calculating machines. The second part treats of the measurement of length, area and volume and also of angles. The different instruments such as calliper-gauges, spherometers, kathetometers, dividing engines, planimeters, liquid and gas-meters are all described and the precautions to be observed in the use of each and the precision attainable are discussed. The illustrations are numerous and clear, but sometimes the descriptions are too concise. The requirements of those interested in technological and industrial applications of physical measurements are kept in the foreground and the treatment is calculated to appeal even to students without much previous knowledge. The history of older systems of units once used in France and the present state of legislation in that country regarding the strictness of adherence to specifications form interesting reading

There are few misprints, but the wrong addition on p. 75 in Vol. II may be corrected. Without being as technical or complete as the articles in Glazebrooke's *Dictionary of Applied Physics* which is often referred to, the fascicules before us give a very useful survey of instruments and methods of measurement, and they may unhesitatingly be recommended to all students of Physics, pure or applied. We await with interest the appearance of the other volumes of the series.

T. S. S.

L' Action Chimique des Rayons Alpha en Phase Gaszeuse. By W. Mund. (Actualités Scientifiques et Industrielles. No. 275. Hermann et Cie, Paris), 1935. Price 15 Francs.

This monograph of forty-six pages deals essentially with the problems raised during the last five years together with a preliminary account of some of the fundamental notions regarding radioactive transformations and α-rays. The reactions induced by the passage of α-rays can be of great help in the study of the mechanism of reactions since the number of ions produced in the gaseous phase could be determined with precision and the "ionic yield" namely, the ratio of the molecules transformed to the number of ions produced, calculated. There are however some limitations such as the non-uniform distribution of energy among the ions produced, etc., but a greater attention paid to these studies by chemists will be highly fruitful.

M. A. G.

Elementary Practical Chemistry. By Arthur I. Vogel, D.Sc. (Blackie & Son Ltd., Glasgow), 1936. Pp. 220. Price 3*s*.

This handy little volume is intended for students of the Matriculation standard of the London University. The series of experiments is fairly comprehensive and the instructions are, in every case, clear and concise. The distribution of exercises on quantitative analysis throughout the book provides a check on the student's progress in practical manipulation. The introduction of the necessary amount of theory and equations for the various reactions involved, adds to the value of the book.

Several useful data, a table of logarithms, and a very valuable section on the treatment of accidents are included in the appendix.

The reviewer feels that the utility of the book could have been enhanced by the inclusion of a few questions and numerical problems.

The printing and get-up are excellent and the price is moderate. The book can be used in the top forms of the High Schools and by fresh-men in the University.

T. RAMANUJIENGAR.

Spectrum Analysis with the Carbon Arc Cathode Layer (Glimmschicht). By Lester W. Strock, Ph.D., with a Preface by Professor V. M. Goldschmidt. (Published by Adam Hilger Ltd., 98 Kings Road, London, N. W. 1.), 1936. Pp. 54. Royal 8vo. Illustrated, bound in limp cloth. Price 5*s*. 6*d*. net. 5*s* 8*d*. post free.

This book gives an account of the special methods of Spectrum Analysis applied to minerals by Professor V. M. Goldschmidt and his co-workers at Göttingen. These methods made possible the systematic work, commenced at Oslo and continued until recently at the University of Göttingen, on the abundance and geochemical distribution of the chemical elements.

The author spent some two and a half years as a visiting investigator at the Göttingen Laboratories and thus is able to present a coherent summary of the work carried out.

He gives an account also of developments in the technique which he himself introduced during this time.

The book is illustrated with several photographs of the apparatus as well as line diagrams and curves.

It should be of interest to all who are concerned with rapid analyses of such non-conducting powders as rocks, minerals, glasses, slags, ashes, clays, soils, etc.

ASTRONOMICAL NOTES.

T. P. Bhaskaran, M.A., F.R.A.S.
(*Nizamia Observatory, Hyderabad.*)

1. **A New Star in Lacerta.**—Information has been received of the appearance of a bright Nova in the Constellation Lacerta on the border of Cepheus (Galactic latitude—2°). It was discovered on the night of June 18 by Dr. Nielson of Aarhus Observatory, Denmark, when its magnitude was estimated to be about 3·5. The Nova is also reported to have been seen by the astronomers at the Stalinabad Observatory, Russia, as a star of the 5th magnitude on the night of June 17. Photometric as well as spectroscopic observations have since been obtained by several observers. Its position as determined by the meredian observations is R. A. $22^h\ 12^m\ 0^s{\cdot}2$ Dec. 55° 7′ 77″ (1900·0). The Nova is identified before outburst as a star of the fourteenth magnitude shown in Barnard's *Atlas of the Milky Way*. The maximum brightness (magnitude 2·3) was reached on June 20 and by June 27 the brightness declined to magnitude 4·7. The Spectrum during the early stages resembled that of a late A type Star (*Astr. Nach.*, 6213) and the subsequent development of the Nova appears to have been specially rapid.

2. **Comet Peltier.**—(1936 *a*).—The first Cometary discovery of the year was made on May 15, by L. Peltier of Delphos, Ohio (U. S. A.), an enthusiastic observer of variable stars. At the time of discovery it was a faint diffuse object of the ninth magnitude, with a central condensation and a short tail. The comet later increased in brightness and on July 27 was conspicuously visible with the naked eye, in the northern sky and showed a small fan-shaped tail. It is moving rapidly southwards and will reach declination 70° S. on August 24.

3. **Absorption of Light in Space and Distribution of Star Density.**—Prof. Van Rhijn has recently published an extensive investigation (*Publications of the Kapteyn Astronomical Laboratory*, No. 47) on the absorption of light in interstellar space and the density distribution of stars in the galaxy. The coefficient of absorption has been discussed from a study of Cepheid Variables, the radial velocities and absolute magnitudes of open clusters and also from the spectroscopic absolute magnitudes of stars (type F to M) determined at Mt. Wilson, the trigonometric parallaxes and secular parallaxes of some groups of stars. The adopted values of the photographic and visual coefficients of galactic absorption are 1·1 and 0·55 magnitudes per 1,000 parsecs for the mean of the northern galaxy. From a discussion of the distribution of star density at various distances he obtains corroboration of the hypothesis of the existence of a local cluster around the Sun possibly extending to not more than 1,000 parsecs. For distances exceeding 1,000 parsecs the changes in star density appear to be relatively small, and are considered to be probably due to the structure of the larger galactic system. In the direction of the centre of the galaxy, the density increases rapidly with distance and at a distance of 900 parsecs, the density is found to be eight times that near the Sun.

4. **Radial Velocities of Extra Galactic Nebulæ.**—In Mt. Wilson Contributions, No. 531, Humason gives a new determination of the apparent radial velocities of one hundred extra galactic nebulæ. Most of them are velocities of recession, the largest being of the order of 40,000 km./sec. for nebulæ in the Bootes Cluster and in the Ursa Major Cluster No. 2. The distances of these nebulæ have been estimated by different methods, to be about 70 million parsecs and the high velocities observed, are in conformity with the velocity distance relationship found in the case of the nearer Nebulæ.

CENTENARIES.

S. R. Ranganathan, M.A., L.T.
(*University of Madras.*)

Rome De l'Isle, Jean Baptiste Louis, (1736-1790).

ROME DE L'ISLE, the French minerologist, was born at Grai on 26th August 1736. The first half of his life appears to have been spent in military service, which he entered in 1757. It is of interest to us to learn that he visited India as the Secretary of a company of artillery. He is said to have lived in Pondicherry and Tranquibar. He was taken prisoner by the English in 1761.

CONTRIBUTIONS TO CRYSTALLOGRAPHY.

After his release in 1764, he returned to France and entered on his scientific career, choosing minerals and crystal forms, as his special field of study. In 1772 he brought out his *Essai de cristallographie.* The second edition of this book came out in 1783 in four volumes under the title *Cristallographie, ou description des formes propres a tous les corps du regne mineral.* This edition included figures of more than 500 crystal forms. This book contains an account of his important discovery that the various shapes of crystals of the same natural or artificial substance are all intimately related to each other. He distinguished the six kinds of primitive forms.

THE CONTACT GONIOMETER.

Rome De l'Isle was fortunate in his assistant, Carangeot who, in addition to making the crystal models for him, invented, in 1780, the Contact Goniometer, which was greatly used by him and his contemporary Abbe Hauy. A duplicate of the original Contact Goniometer used by Rome De l'Isle came into the hands of the Duke of Buckingham and was eventually deposited in the University Museum at Oxford.

HIS OTHER PUBLICATIONS.

In addition to his *Cristallographie*, Rome De l'Isle published seven papers and three other books. The book entitled *Des Caracteres exterieurs des mineraux* came out in 1784 and the *Metrologie ou tables* came out in 1789. These books and the papers came out regularly in the last decade of his life, almost to the year of his death. This shows how active he was throughout his life. He died at Paris on 7th March 1790.

THE MINERAL ROMEITE.

In the *Annales des mines* of 1841, Damour immortalised the name of Rome De l'Isle by giving the name Romeite to a honey-yellow crystal of an antimonite of calcium, which occurs in minute octahedrons.

* * *

Leach, William Elford (1790-1836).

LEACH, the British Zoologist, was born at Plymouth in 1790. Though he got the Doctorate in medicine of the University of Edinburgh in 1812, he abandoned the medical profession to devote himself to natural history. This made him enter service in the British Museum in 1813. He served this institution for nine years, first as Assistant Librarian and later as Assistant Keeper of the natural history department. Those nine years of Leach's life in the British Museum were one of such absorption and overwork that both his body and mind broke down when he was but 31 years. This led to his retirement in 1821 and his migration to Italy, where he was looked after by his most devoted sister.

CONTEMPORARY ESTIMATE OF HIS REPUTATION.

But, during this short period of 9 years, Leach had earned a great reputation at home and abroad. At the anniversary meeting of the Royal Society, H. R. H. the Duke of Sussex, referred to him in the following terms in his presidential address :—"His enthusiastic devotion to his favourite studies, his great knowledge of details, combined with no inconsiderable talents for classification, were eminently calculated to raise him to the very highest eminence as an original and philosophical naturalist..... We are chiefly indebted to him for the first introduction into this country of the natural system of arrangement in conchology and entomology." The Secretary of the Linnean Society referred to his death in equally high terms as "one of the most laborious and successful as well as one of the most universal cultivators of Zoology which this country has ever produced." He was elected a Fellow of the Royal Society in his 27th year.

HIS WORK AND PUBLICATIONS.

Although he had made extensive discoveries in vertebrata, especially birds, he is best remembered for his work in malacology and entomology. It is claimed that his knowledge of the crustacea was superior to that of any other naturalist of his time. He was a profuse writer. During the nine years of his active scientific life, he contributed no less than 31 papers to the organs of learned societies, and in addition four voluminous treatises entitled respectively (1) *The Zoological Miscellany*, 3 Vols., (2) *Malacostraca podophthalma Britanniæ*, (3) *Systematic catalogue of the indigenous mammalia and birds*, (4) *A synopsis of the mollusca of Great Britain*. He also described the animals taken by the Congo Expedition and contributed articles to several encyclopædias.

THE END.

No wonder that such an output in the first 9 years of active life led to a premature termination of his labours. After 15 years of slow recovery and secluded life under the care of his sister, he died of cholera in Italy on 25th August 1836.

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Black, Greene Vardimen (1836-1915).

G. V. BLACK, the American dentist, was born on 3rd August 1836 at Winchester, Illinois. At 17, he took up the study of medicine and three years later he became an apprentice in dentistry. A year later he began practice in his own town and later in Jacksonville. He was Lecturer in Dentistry at the Missouri Dental College from 1870 to 1880. He then became Professor of Dentistry in the Chicago College of Dentistry (1883–1889), in the University of Iowa (1890–91) and in the North-Western University Dental School (1891–1915). He was the Dean of the last-mentioned school from 1897. It is an unusual coincidence that his son, Dr. Arthur Davenport Black, who is also an eminent dental surgeon, was Professor of Operative Dentistry for many years during his father's deanship and himself continues as the dean from 1917.

HIS WRITINGS.

Black's first paper appeared in the July 1869 issue of the *Missouri Dental Journal*. He was a frequent contributor to several dental periodicals of America. He also published several books on dentistry. His first book came out in 1884 under the title *The formation of poisons by micro-organisms*. In 1887 came *A study of the histological characters of the periosteum and peridental membrane*. The two famous books of his are the *Dental Anatomy* (1891) and *The Operative Dentistry*, 2 V. (1908). At a banquet tendered to him five years before his death by the Chicago Odontographic Society, a pamphlet was distributed containing more than 500 titles of books, papers and reports written by him. At the time of his death, it was estimated that their number had reached 1,000.

HIS CONTRIBUTIONS.

Black was a pioneer in many departments of dentistry. The pages of *Dental Cosmos* contain many of his discoveries. He gave the successful rule of practice for dentists in preventing the loss of workability by cohesive gold when stored in the dental cabinet. He evolved a method of making alloys for amalgam as a filling for tooth cavities. He invented the cord driven, foot power, dental engine. He supplied the patterns for 102 cutting instruments necessary for the proper excavation of cavities. He steadily refused to commercialise his work and freely placed all the results of his labours at the disposal of his profession.

HIS HONOURS.

In 1901, he was elected President of the National Dental Association of America. Five universities conferred Honorary Degrees on him. In 1910, he was the first recipient of the Miller Memorial Prize awarded by the International Dental Federation for "eminent services to dentistry". This international prize was established by the Federation in memory of its president Professor Miller of the Berlin University. The award is biennial and consists of a gold medal, a diploma of honour and the interests of a fund of £3,000. His former pupils are said to be scattered over the world—in America, in Europe, in Asia, Africa and Australia. His activities continued till within a few weeks of his death. In 1915, appeared his last book, *Diseases and treatment of the investing tissues of the teeth and the dental pulp*, and his last article appeared in July 1915, while he died on August 31. An estimate of his personality was given as follows by one of his colleagues. "He was great in achievements, great also in his simplicity and sincerity. He climbed the heights, but he took his fellows with him every step of the way."

OBITUARY.

Dr. Panchanan Mitra.

DR. PANCHANAN MITRA, Head of the Department of Anthropology of the University of Calcutta, died suddenly at his residence in Calcutta on the 25th of July last, after a short illness, at the early age of 45. He was born in 1891 and was the grandson of the (late) Raja Rajendra Lal Mitra, one of the most distinguished scholars of his time and the first Indian to become the President of the Asiatic (now Royal) Society of Bengal, Calcutta.

After a distinguished career in the Calcutta University Dr. Mitra acted for a short time as a Lecturer in English in the Bangabashi College, but early turned his attention to Prehistory and was awarded the Premchand Raichand Scholarship of the Calcutta University in 1919. The same year he was appointed on the staff of the Department of Anthropology which was started by the late Sir Asutosh Mukherji. In 1929 he was awarded a Fellowship of the Bishops Museum of Honolulu through the good offices of Prof. Craighill Handy who desired an Indian scholar to visit Polynesia and study the possible sources of Indian influence in that region. The results of Dr. Mitra's researches in Polynesia have been incorporated in a monograph entitled *Indian Cultural Influence upon Polynesia* which will soon be published by the Bishops Museum. He received his PH.D. degree from the Yale University for his thesis on "The History of American Anthropology" in 1931. The same year he visited several prehistoric sites in France and Spain as a member of the American School of Archæology in France. After his return to India in 1932 Dr. Mitra was given charge of the Department of Anthropology on the retirement of Dewan Bahadur Dr. L. A. Ananthakrishna Iyer. Dr. Mitra performed his teaching work in the Calcutta University with great devotion and enthusiasm and was mainly responsible for organising the Department in its new rooms in the Science College, Ballygunge.

He presided over the Anthropological Section of the Indian Science Congress in 1933 and was the author of several articles in addition to two books on "Prehistory of India" and "History of American Anthropology" published by the Calcutta University. He was also a Councillor of the Calcutta Corporation in 1924, and took a keen interest in many religious associations.

B. S. G.

Lt.-Col. R. Knowles, C.I.E., M.R.C.S., L.R.C.P., I.M.S.

LT.-COL. R. KNOWLES, C.I.E., M.R.C.S., L.R.C.P., I.M.S., acting Director of the Calcutta School of Tropical Medicine, died on 3rd August at the Tropical Diseases Hospital, of heart failure following gastric hæmorrhage.

Lt.-Col. R. Knowles, son of Rev. J. Knowles, was born on 30th October 1883, at Quilon, Travancore. After a distinguished educational career at Cambridge and London, he entered the I.M.S. in 1908, and moved all round India, on military duty for the next 5 years. He was appointed in 1912 Assistant Director, Pasteur Institute of India, Kasauli, and in August 1914, he served as medical officer, 110th Maharatta Light Infantry, Indian Expeditionary Force, Mesopotamia. In 1916, he was appointed Director to organise the newly started King Edward VII Memorial Pasteur Institute, Shillong, which post he relinquished in 1920 to take up the Professorship of Pathology, Calcutta Medical College, as successor to Sir Leonard Rogers who at that time was raising funds to establish a School of Tropical Medicine. When Sir Leonard Rogers retired owing to ill-health, he chose Lt.-Col. Knowles, to organise the School of Tropical Medicine. In 1921, he was appointed Professor of Protozoology, Calcutta School of Tropical Medicine and Hygiene, which post he held until his death. He was Assistant Editor, (1922-1928) and later Editor, *Indian Medical Gazette*. Lt.-Col. Knowles was well known for his numerous scientific papers and memoirs, bearing on medical protozoology.

WE have to record the death of Dr. F. J. F. SHAW, D.Sc., I.A.S., in Pusa on the 29th July. He was Director of the Agricultural Research Institute at Pusa and was officiating as Agricultural Expert to the Imperial Council of Agricultural Research.

Rancidity.

By N. N. Dastur and B. N. Banerjee.
(*Department of Biochemistry, Indian Institute of Science, Bangalore.*)

I. Development of Rancidity.

BOTH on account of its commercial and its scientific importance, rancidity is a subject which arouses perennial interest. Animal and vegetable fats and oils become rancid under certain conditions. The change is primarily autoxidative in character and is very often accompanied by secondary reactions such as molecular condensation, the development of colouration and undesirable odours. Raw vegetable oils have generally better keeping qualities than animal fats, primarily because of certain antioxidative principles present in them.[1] The natural antioxidants present in olive and linseed oils can be removed almost completely by repeated boiling with water.[2] Refined oils are less stable than natural oils, chiefly because of the removal of antioxidants in the process of refining. It is significant that vegetable oils are rich in aliphatic acids.

When exposed to oxygen, natural fats exhibit the typical characteristics of an autocatalytic oxidation. There is a latent or induction period during which the amount of oxygen absorbed is very small. After this the rate of oxygen absorption increases and the onset of rancidity generally coincides with the end of the induction period.

Among the many factors that have been mentioned as accelerators in the production of rancidity may be mentioned heat,[3] light,[4] acidity,[5] moisture,[6] enzymes,[7] metals[8] and speaking very broadly, any physical factor capable of adding energy to the system.

Conflicting views have been held regarding the role of moisture as a catalyst in the oxidation of fats. It is now generally believed that the presence of moisture has a retarding action upon the development of rancidity.[9] Moisture prevents the formation of aldehydes and ketones which are stable products and which produce the tallowy odours and flavours. In a humid atmosphere the end products are acids without tallowy odours. Since acids act as catalysts in oxidation processes, it should be expected that after a preliminary stage, the rate of oxidation would increase. It is also probable that the action of moisture varies greatly with the nature of the fat in question.

Several theories have been propounded from time to time with a view to elucidating the mechanism of autoxidation. All of them agree in one point, *viz.*, that the first change in the reaction consists in the addition of molecular oxygen to the double bond of the unsaturated acids with the production of highly reactive peroxides. These peroxides then isomerise, decompose into, or react with water to form a complex series of products like aldehydes, ketones and acids of lower molecular weight. A thorough knowledge of the chemical changes taking place during rancidity will be of scientific interest while a clear understanding of the bearing of the initial stages would be of great practical value.

Animal fats are abundant in caratinoid pigments. Most of the workers are agreed that they function as procatalysts.[10] Again, neutral substances like sterols become proxidants after irradiation.[11]

Light has an accelerating action on the autoxidation of fats.[12] There is no doubt that oxidation takes place continually in oils and fats, but this action proceeds more rapidly in the presence of light than in the dark. Experimental evidences show that green light delays the development of rancidity almost to the same extent as does the exclusion of all light.[13] Disappearance of ability to absorb blue light is apparently accompanied by development of rancidity. Invisible ultra-violet light has also the same accelerating effect as blue light. The process is autocatalytic, *i.e.*, once oxidation has set in, removal of the source of light does not reduce the rate to that of the unexposed fat.[14] The reaction continues to proceed in the dark at a rate depending upon the amount of oxygen already present. From this it may readily be seen that the potential storage life of many fatty products is seriously impaired by the methods employed in their manufacture.

There is now ample evidence to show that the organoleptic rancidity is not developed when the oil is protected from light.[15] In fact, it has been claimed that light alone is sufficient for the production of rancidity,[16] as fats will produce the odour and taste typical of rancidity, in the absence of air when exposed to light.

Temperature is another factor that accelerates rancidity. Heating at 100° C. has more marked effect on production of rancidity than exposure to air.[17] Exposure to temperatures upto 50° C. has no marked effect, which shows that at 100° C. some intramolecular change is probably taking place. The best temperature for preservation is 0° C. or lower. It has been shown by several

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1 Matill and Crawford, *Ind. and Eng. Chem.*, 1930, **22**, 341.

2 Banks and Hilditch, *J. Soc. Chem. Ind.*, 1932, **51**, 411T.

3 Bevis, *J. Soc. Chem. Ind.*, 1923, **42**, 417T.

4 Greenbank and Holm, *Ind. and Eng. Chem.*, Anal. Edn., 1930, **2**, 9.

5 Holm and Greenbank, *Ind. and Eng. Chem.*, 1924, **16**, 518.

6 Davies, *J. Soc. Chem. Ind.*, 1928, **47**, 185T.

7 Pennington and Hepburn, *J. Am. Chem. Soc.*, 1912, **34**, 210.

8 King, *et al.*, Oil and Soap, 1933, **10**, 204.

9 Greenbank and Holm, *Ind. and Eng. Chem.*, 1924, **16**, 598; French, Olcott and Matill, *Ind. and Eng. Chem.*, 1935, **27**, 724; Holmes, Carbet and Hartxler, *Ind. and Eng. Chem.*, 1936, **28**, 133.

10 Greenbank and Holm, *Ind. and Eng. Chem.*, 1934, **26**, 243.

11 Matill and Crawford, *loc. cit.*

12 Greenbank and Holm, *Ind. and Eng. Chem.*, Anal. Edn., 1930, **2**, 9.

13 Coe and Le Clerc, *Ind. and Eng. Chem.*, 1934, **26**, 245.

14 Lea, *Proc. Roy. Soc.*, London, 1931, **108B**, 175.

15 Coe and Le Clerc, *loc. cit.*

16 Wagner, *Z. Nahr. u. Ghnussm*, 1913, **25**, 704.

17 Bevis, *loc. cit.*

workers that each increase in temperature by 10° C. approximately doubles the rate of increase of rancidity.[18]

Certain metals in oil-soluble form are known to have a marked effect on the stability of fats. Copper is a powerful proxidant for autoxidative reactions. The use of copper equipment in the handling of milk and its products is thus a potential source of danger. Manganese in somewhat higher concentrations, likewise, has a strong proxidation effect; but ferrous iron, tin and nickel at low concentrations have no effect. Zinc has a stabilising action. Generally, the materials used for wrapping fatty products also contain some of these metals in soluble form and may thus act as promoters of rancidity.

As has been pointed out before, the oxidative rancidity involves the oxidation of the unsaturated bonds. Absorption of small amounts of oxygen produce tallowy odours and flavours and, as such, deterioration through oxidation can be prevented by preventing the initial changes. With this object in view, several substances which retard the uptake of oxygen (antioxidants) are used as preservatives. Their use first originated with the classical researches of Mouren and Dufraisse.[19] The efficiency of autoxidative catalysts rests entirely upon the relationship between their susceptibility to oxidation and their catalytic properties. Theoretically, any oxidisable substance should be capable of acting as an autoxidative catalyst under proper conditions. Hydroxy-derivatives of aromatic compounds (poly-phenols) are the most effective inhibitors of oxidation. Activity is associated in some manner with the ortho- or para-configuration.[20]

Rancid products can be materially improved by removing the products of decomposition such as acids, aldehydes, etc. With this object in view, numerous processes have been patented. However, all these treatments can only be regarded as temporary improvements, since fat so purified will again become rapidly rancid.

In view of what is known concerning the factors responsible for producing rancidity, it may be said that to insure good keeping quality great stress should be laid on the freshness of the fat in the product.

II. Methods for Determining Rancidity.

While it is true that the recognition of rancidity by taste and odour is so easy that there is no need for the use of chemical tests, there are nevertheless many cases in which reliable tests may prove of great value. For instance, rancid fat may be mixed with fresh fat in order to disguise its condition and thus be sold as a fresh product. A large number of methods have therefore been proposed from time to time for estimating rancidity, *e.g.*, acid value,[21] iodine value,[22] organic peroxides,[23] colour estimation for aldehydes or other products of oxidation,[24] permanganate titration of water-soluble volatile constituents,[25] and the fading of methylene blue colour.[26] None of the above methods is, however, quite reliable, since the chosen component may be the product of a secondary process and before a final conclusion can be drawn about the state of a fat, it should be examined by at least three or four different methods.

III. Rancidity Changes in 'Ghee'.

Ghee is prepared exclusively from butter fat, from which the water is expelled by heat. The butter is allowed to become somewhat acidic and is then clarified by melting and decantation.

In India, ghee is regarded as a very valuable product and is consumed in large quantities. A similar product is used in Egypt and is known as 'samna'. Besides being an important item of food, it is the chief source of vitamin A. Ghee is more important than milk for the reason that it is more concentrated and affords an easy method for disposal of extra amounts of milk. But, on account of its high content of lower fatty acids, especially butyric acid, upon slight hydrolysis, ghee produces a strong characteristic odour of these acids. Most of the other fats are rich in higher acids, like stearic, palmitic, etc., which are odourless. On hydrolysis these fats give comparatively little of the 'off' odours. Again, oxidation of unsaturated acids like oleic and linoleic is responsible for the tallowy odours. It will thus be seen that milk fat presents a combination of fatty acids which due to hydrolysis may cause intense rancidity or tallowiness due to oxidation.

Though much work has been done on various aspects of rancidity little is known about its effect on the vitamin A content of the milk fat. Since rancidity is primarily an oxidation reaction this might naturally affect its vitamin A content.[27] It would be interesting to study the various factors which favour the development of rancidity in ghee and their effect on vitamin A and to ascertain whether a higher vitamin A content is an index of increased stabilty of the product.

Again it is necessary to find some cheap, and efficient method of stopping this spoilage. In the case of an edible fat like ghee, only non-toxic and harmless antioxidants can be used as preservatives. Antioxidants like lecithin, 'jagari', hydroquinone, etc., can be tried for ghee. The effect of these antioxidants on the stability of vitamin A should also be studied. It has been quite recently shown that a combination of two antioxidants affords a remarkably strong protective action which is greater than what could be expected from the mere additive effect.[28]

It is well known that while ghee prepared under good conditions can be preserved with care for

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18 Morgan, *Ind. and Eng. Chem.*, 1935, **27**, 1287.

19 Mouren and Dufraisse, *Chemical Reviews*, 1927, **3**, 113.

20 Matill, *J. Biol. Chem.*, 1931, **90**, 141.

21 "Animal and Vegetable Oils, Fats and Waxes" by G. Martin, p. 152.

22 DeGroote, *et al.*, *Ind. and Eng. Chem.*, Anal. Edn., 1931, **3**, 243.

23 Davies, *loc. cit.*; Taffel and Bevis, *J. Soc. Chem. Ind.*, 1931, **50**, 87T; Lea, *loc. cit.*; Wheeler, *Oil and Soap*, 1932, **9**, 89.

24 Kerr, *J. Ind. and Eng. Chem.*, 1918, **10**, 471; Schibsted, *Ind. and Eng. Chem.*, Anal. Edn., 1932, **4**, 204; Lea, *Ind. and Eng. Chem.*, Anal. Edn., 1934, **6**, 241.

25 Kerr and Sorber, *Ind. and Eng. Chem.*, 1923, **15**, 383.

26 Greenbank and Holm, *Ind. and Eng. Chem.*, Anal. Edn., 1930, **2**, 9.

Royce, *Ind. and Eng. Chem.*, Anal. Edn., 1933, **5**, 244.

27 Powick, *J. Agric. Res.*, 1925, **31**, 1017.

28 Holmes, *et al*, *Ind. and Eng. Chem.*, 1936, **28**, 133.

about six months, the bazaar ghee is usually seldom stable for more than a fortnight. Apart from the question of vitamin A, rancid ghee has no market value and therefore in an agricultural country like India preservation of ghee for sufficiently long periods of time is economically important.

Milk fat, like all other fats, does not absorb oxygen as soon as it comes in contact with it but passes through an induction period. At lower temperatures this period is considerably longer. Presence of moisture is detrimental as it hydrolyses lecithin to trimethylamine, which, in turn, produces a fishy odour. A measure of the length of the induction period will furnish a valuable index of the keeping quality and freshness of a ghee sample.

Acidity is another important factor determining rancidity. Sweet cream butter may be stored for long periods with very little change in flavours.[29] Cold storage of milk fat is advantageous in that it prevents the development of acidity, but it also prevents the destruction of lipase due to low acid concentration. Lipase liberates the lower and volatile fatty acids which are responsible for 'off' flavours. Thus, butter preserved in the cold gets rancid in a comparatively short time when raised to room temperature.

Inert gases have been extensively adopted for the purpose of preserving fats. Carbon dioxide (15 per cent.) retards the onset of rancidity in beef fat stored at 0°C.[30] However, according to some authors,[31] carbon dioxide cannot be considered as an inert gas for dairy products containing milk fat since the increased acidity hydrolyses the glycerides into fatty acids.

In connection with the development of rancidity in ghee it may be mentioned that enzymic action plays very little part as these are destroyed during its preparation. Some workers do not attach much importance to bacterial action as well. Jensen and Grettie[32] have reviewed the general question of the action of micro-organisms on fats. It is not unlikely, that micro-organisms play an important role since it has been mentioned by several investigators that the development of moulds has an adverse effect on the stability of milk fat.[33] Rancidity can be caused by 'Ps. fluorescens'.[34] This conclusion is further supported by the fact that the storage of ghee in unclean vessels leads to its spoilage. The beneficial action of zinc is noteworthy in this connection.

Milk fat contains higher alcohols like sterols and lipoids like lecithin. A study of the effect of these constituents on the stability of ghee and vitamin A may lead to very interesting results.

[29] Rogers, *Proc. Third. Internat. Cong. Refrigeration*, 1913, **2**, 667.

[30] Lea, *J. Soc. Chem. Ind.*, 1933, **52**, 9T.

[31] Holm, Wright and Greenbank, *J. Dairy Sci.*, 1927, **10**, 33.

[32] Jensen and Grettie, *Oil and Soap*, 1933, **10**, 23.

[33] Bevis, *J. Soc. Chem. Ind.*, 1933, **42**, 417T.

[34] Derby and Hammer, *Iowa Agr. Expt. Station Research Bull.*, 1931, No. 145.

RESEARCH NOTES.

MATHEMATICAL AND PHYSICAL.

Determination of Dirichlet's Series Satisfying a Functional Equation.—Hecke (*Math. Annalen*, 112 Band, V Heft, pp. 661—699) has solved a very general problem (the particular case of the Riemannian Zeta-function being determined from its functional equation had been solved earlier by Hamburger), concerning the determination of functions satisfying a functional equation analogous to that of the Riemannian Zeta-function and some regularity conditions. Let λ, k, be +ve constants and $r = \pm 1$. Let $\phi(s)$ be such that $(s-k)\phi(s)$ is an integral function of finite order; and $\left(\frac{2\pi}{\lambda}\right)^{-s}\Gamma(s)\,\phi(s) = \mathrm{R}(s) = r\mathrm{R}(k-s)$; and let $\phi(s)$ be expansible as a Dirichlet series of the special form $\Sigma \frac{a_n}{n^s}$ which is convergent for some value of s. Each of such functions $\phi(s)$ is said to belong to the signature $\{\lambda, k, r\}$. The problem he has handled is the determination of the number of linearly independent ϕ's. To each such function ϕ, another function $f(\tau)$ is made to correspond. $f(\tau)$ is defined in the following manner. Let $\mathrm{F}(x) = \sum_{1}^{\infty} a_n e^{\frac{-2\pi n x}{\lambda}}$. Then by means of Mellin's integral it is also $= \frac{1}{2\pi i}\int_{\sigma_1} \frac{\mathrm{R}(s)}{x^s}\,ds$ where the integral is taken along the line $\mathrm{R}(s) = \sigma_1$, $\{\phi(s)$ converges absolutely for $s = \sigma_1\}$; and $\mathrm{C}_k = \left(\frac{2\pi}{\lambda}\right)^{-k}\Gamma(k)\alpha$, where α = the residue of $\phi(s)$ at k. Then $f(\tau) = r\mathrm{C}_k + \mathrm{F}(-i\tau)$ where $x = -i\tau$. The conditions which are satisfied by $\phi(s)$ give rise to corresponding conditions which should be satisfied by $f(\tau)$. The conditions (regularity conditions are omitted) are

$$(1)\ f(\tau+\lambda) = f(\tau) \qquad (2)\ \frac{f\left(-\frac{1}{\tau}\right)}{(-i\tau)^k} = r f(\tau).$$

[The equations are analogous to those satisfied by elliptic modular transcendentals for $\lambda = 1$.] He has shown in a natural way that the problem for ϕ is identical with that of f. The results that he obtains do not assume the acquaintance of the general theory of automorphic functions; he only uses simple theorems on conformal representation. The results he obtains are the following:

I. when $\lambda > 2$, there exists an ∞ of linearly independent ϕ.

II. when $\lambda = 2$, the number of linearly independent $\phi = \left[\frac{k}{4}\right] + 1$, for $r = 1$, and $= \left[\frac{k-2}{4}\right] + 1$ for $r = -1$. [for $k < 2$ no such ϕ exists.]

The case when $0 < \lambda < 2$ is very interesting

[If G (λ) is the group formed out of the substitutions $U(\tau) = \tau + \lambda$. $V(\tau) = -\frac{1}{\tau}$, the fundamental region of the group is conjectured by Hecke to lie inside the region $|T| \geqslant 1$, $-\lambda/2 \leqslant R(T) \leqslant \lambda/2$. When $\lambda > 2$ the fundamental region is connected. [This is the reason for the diversity of the results when $\lambda \geqslant 2$. when $\lambda < 2$.] In this case, ϕ exists only when $\lambda = 2 \cos\frac{\pi}{q}$, $k = \frac{4A}{q-2} + 1 - r$, where q and A are positive integers $[q \geqslant 3]$; in that case the number of linearly independent $\phi \leqslant \left[\frac{A + \frac{r-1}{2}}{q}\right] + 1$, and in case ϕ is regular at $s = k$, the number is equal to $\left[\frac{A + \frac{r-1}{2}}{q}\right]$. Therefore in case $0 < \lambda < 1$ there do not exist any ϕ at all. In ease $\lambda = 1$, then $q = 3$ and G (λ) is the modular-group. ϕ only exists when k is even and $r = (-1)^{k/2}$). The number is then $\left[\frac{k}{12}\right]$ when $k = 2$ [mod 12], $= 1 + \left[\frac{k}{12}\right]$ otherwise.

He has also considered the Zeta-functions of various algebraic fields and L-functions, and their determination by means of the preceding analysis. By means of an interesting artifice, he has proved a finiteness theorem in case $\lambda > 2$ by introducing a series of functions $\phi_\varepsilon(s)$, and considering a Matrix equation in $R\alpha(s)$ instead of the functional equation for R (s). In the case of the quadratic field $k[\sqrt{D}]$, $\{D > 0\}$, some specially formed Zeta-functions satisfy equations of the preceding type. K. V. I.

Conservation of Energy and Momentum in Individual Processes.—The accepted theory of the Compton effect is based on the law of conservation of energy and momentum in individual encounters between a quantum and an electron. The experiments of Bothe and Geiger have shown that the law is true as far as the scattering of X-rays by electrons is concerned. It was therefore a great surprise when Shankland,[1] using high energy γ-rays failed to observe more than chance coincidences between the kicks of two counters one of which detected the recoil electrons and the other recorded the scattered γ-ray photons. The attention of physicists was more strongly drawn to this result because Dirac[2] expressed the opinion that this experiment seemed to be in the favour of the view of Bohr, Slater and Kramers that the laws of conservation of energy and momentum were only statistically true and did not hold in the case of individual processes. Although Dirac sought in this way to do away with a number of difficulties in the theory of Radiation, the belief in the conservation laws could not be so easily shattered. The question whether the scattered photons were instantaneously ejected or not was decided by Piccard and Stahel[3] by making γ-rays fall on a quickly rotating sector of Al, Fe, or Pb kept before two compensated ionisation chambers which could indicate an excess of photons or electrons. They found that to the order of accuracy of 10^{-7} sec. the ejection of the recoil electron and that of the scattered photon were simultaneous. Now Jacobsen[4] in Copenhagen and Bothe and Maier-Leibnitz[5] in Göttingen, have repeated Shankland's experiment under more precisely known conditions. Thus, whereas Shankland used the inhomogeneous γ-rays from Radium, the other investigators used the more homogeneous radiation from a Thorium preparation and found more coincidences than chance could account for.

Jacobsen allowed the γ-rays from a source of 10 mg. of Radio-Thorium, filtered by 0·5 cm. of lead, to pass through a hole $1 \times 1{\cdot}5$ cm.^{2} in a lead block of 30 cm. thickness. The γ-rays were then scattered by a paraffin screen. The β-ray and γ-ray counters were both kept at 30° to the direction of incidence. The results are summarised in the following table. Chance coincidences were found out by having a lead sheet of 2 mm. thickness before the β-ray counter.

Expt. No.	Kicks per minute				Coincidences per hour		
	Without scatterer		With scatterer		Total without Pb sheet	Chance with Pb plate	Difference
	β-counter	γ-counter	β-counter	γ-counter			
I	120	28	195	29	6·5 ± 0·6	2·3 ± 0·3	4·2
II	120	120	195	121	11·7 ± 0·9	8·6 ± 0·7	3·1

Jacobsen concluded that the increase in the number of coincidences due to the presence of the scatterer was of the expected order when the laws of conservation were assumed to hold in single encounters and due allowance was made for the inhomogeneity of the primary radiation, scattering within the paraffin and so on.

Bothe and Maier-Leibnitz used Radio-Thorium equivalent to 20 mg. of Radium and employed a cellophane sheet of 0·028 grm./cm.^{2} as the scatterer. The β-ray and γ-ray counters were set at 30° to the incident rays and were of aluminium with a wall thickness of 0·08 mm. and an effective surface of 12×20 mm.^{2} They were placed at a distance of 45 mm. from the scatterer. The table below gives the results obtained by them.

[1] *Phys. Rev.*, 1936, **49**, 8.
[2] *Nature*, 1936, **137**, 298.
[3] *Naturwiss.*, 1936, **24**, 413.
[4] *Nature*, 1936, **138**, 25.
[5] Göttinger, *Nachr.*, 1936, **2**, 127.

Expt. No.	Kicks per minute			Coincidences in 14·5 hours			Chance coincidences per 1,000 Electrons
	Electron counter		Photon counter	With scatterer	Without scatterer	Excess	
	With scatterer	Without scatterer					
I	85	45	41	25	5	20 ± 5·5	0·6
II	140	88	86	95	34	61 ± 11	1·4

Since the observed excess of coincidences is enormously larger than the expected increase of chance coincidences, the authors conclude that their experiment fully confirms the photon theory of the Compton effect. Bohr,[6] after considering these results, says that there is no longer any reason to doubt the validity of the laws of conservation of energy and momentum in individual processes and the successes of the neutrino theory point in the same direction. The difficulties of quantum electrodynamics have to be removed by a more penetrating analysis, taking into account the atomic nature of electricity as pointed out by Bohr.

T. S. S.

Sonic Activation in Chemical Systems Oxidations at Audible Frequencies.—It is well known that ultrasonic radiations can induce or accelerate many chemical reactions. Flosdorf, Chambers and Malisoff (*J. Am. Chem. Soc.*, 1936, **58**, 1069) have carried out some experiments which demonstrate for the first time, the possibility of such effects being brought about by even audible frequencies. It is found that water and aqueous solutions of sodium bisulphate and sodium chloride can be oxidised by dissolved oxygen, on irradiation by sonic frequencies of about 9,000 cycles per second. The oxidations appear to be accomplished through the production of activated oxygen in association with cavitation.

K. S. G. D.

Durability of Moulding Sands.—In a recent publication (*University of Illinois Bulletin* 281) Casberg and Schubert have briefly described the procedure adopted in carrying out the tests by the 3 methods employed, *viz.*, the mould test, oven test and Hydration and Dehydration methods. They have set out in detail the result obtained by them using two natural sands, *viz.*, Albany and Mulberry grove sands and two synthetic sands obtained by mixing Ohio clay and bentonite clay to silica sand. The results disclose rather a wide difference in the durability amongst natural sands but they show how by addition of bentonite, the life may be increased. They have, from the experiments, concluded that it would be more economical to add clay after using sand for some heats and that durability depends on physical and chemical properties of the minerals found in the bonding substances.

This pamphlet will be very useful to those engaged in foundry and research work since in addition to the authors setting out the results of their tests they have also added a Bibliography of recent American publications on the subject.

E. K. R.

Nepheline Contrasts.—During the discussion of his paper on nepheline at the International Geological Congress in South Africa, Dr. Morozowicz maintained that whatever the rock in which it was found, nepheline had a constant chemical composition. In order to show that the composition depends upon the magma from which it crystallised, Bowen collected a series of samples from South Africa and made a detailed study (*American Mineralogist*, **21**, No. 6) of the optical and chemical properties of this mineral. The specimens were collected from two distinct areas—one in a series of soda-rich rocks and the other in a potash series of rocks. In the soda rich rocks the mineral is rich in both nepheline and albite molecules, thereby showing that the mineral is highly siliceous. On the other hand, in the potash series of rocks the mineral nepheline is rich in kaliophilite, and the albite molecule is reduced to one per cent. In the optical properties there is a slight difference in refractive index,—those formed from magmas poor in K_2O having a lower refractive index than those formed from magmas of high K_2O content which is in conformity with the conclusions of Bannister and Hey. Further, with the help of an equilibrium diagram, Bowen has shown that the variation in the composition of the magma is a main factor responsible for the variations noticed in the character of the nepheline.

The Solubility of Quartz.—That deficiency in silica during lateritisation is due to solution of quartz during the earlier phases of this process has been established by the work on the Malabar laterites recently conducted in Lacroix's laboratory in Paris. But the corrosion and etching so frequently noticed in quartz pebbles constituting the conglomerates and quartzites have been assigned to various other causes, such as the different solvents present in underground water. Recently in a note published, Dr. Fox (*Geol. Sur. of India Rec.*, **69**, Pt. 4) has examined such surface features on quartz pebbles from different localities in India, and he opines that in certain cases they are due to animal agency. It is interesting to note that he has actually detected certain tiny larvæ-like creatures in some of these holes in quartz pebbles which are as small as 1/32 of an inch. From this he suspects that the solvent action of either the saliva or other secretions of such animals is probably responsible for such a surface corrosion.

[6] *Nature*, 1936, **138**, 25.

BIOLOGICAL.

Seedling Method as a Means of Determining the Requirements of a Soil for Fertilisers.—The claims of a method somewhat similar to the Neubauer and Schneider method of testing soils are brought out in a study by L. L. Golodkovsky and reported in the *Bulletin of Soviet Union Scientific Research Cotton Institute*, *Sejusnihi*, 1935, **6**. The experiment subdivides the seedlings into three groups according to the weight and size of the seeds used, *e.g.*, 10 seeds $> \cdot 4$ gr.; 10 seeds $> \cdot 03$ and $< \cdot 4$ gr.; and 10 seeds $< \cdot 03$ gr. The size and weight of the seeds was found to be inversely proportional to the response of the seedlings to plant nutrients, but the smallest seeds gave plants which were too weak to stand the conditions of the experiment; the middle size group was therefore found most suitable and these showed the best response to N and P_2O_5. The 30 plants tested at the seedling stage showed a difference in their requirement of plant nutrients according to supplementary nutrients stored in the seed (albumins and carbohydrates). The seed pans contain 200 gr. of soil and each pan grows 20 seedlings which are harvested 20–25 days after germination. Among the plants tested rice and tomatoes were found to be highly responsive, the rice to nitrogen and the tomatoes to phosphates. The data furnished by this method were found to agree closely with those arrived at by field or pot experiments, and the method of using rice seedlings for nitrogen and tomato seedlings for phosphate requirements of soils is recommended for working out the fertiliser requirements of different classes of soils in practice. The apparent simplicity and quickness of the method make it worthy of being tested for soils in this country also.

A. K. Y.

Can Arrowed Sugarcane be used as Planting Material?—The suitability of cane setts cut from arrowed canes as compared with those from young cane is the subject of a study reported in the *Phillipine Agriculturist*, **25**, No. 1. Seed setts from arrowed canes were pieces cut with nodes bearing side shoots actively growing; these were trimmed to diminish transpiration and used for planting; setts from young cane were those from six months old cane cut into pieces each containing two to four or more buds. The results showed that in regard to germination both kinds came up well, the cut setts giving a 7·5 per cent. better germination in December planting and the arrowed setts giving a 36.4 per cent. better germination in the February planting. This difference was also reflected in the stand of the cane in the two different seasons. As regards yields of cane the arrowed setts gave a significantly higher yield than the cut setts in the February planting while in the December planting the yields showed no difference between each other. On the whole it may be said that arrowed cane setts were found quite as suitable as cut setts, while on the other hand in the February planting they were found decidedly superior in germination, stand of cane and yields of cane and sugar. These conclusions are of much value because there are times when cane arrows profusely and it then becomes impossible to obtain planting material in the usual way, that is from young or unarrowed cane.

A. K. Y.

Lanital—A New Artificial Fibre, being a Substitute for Wool.—In the wake of the artificial fibres rayon and staple fibre intended and used largely as artificial silk and cotton comes the production of artificial wool, a still another attempt by the great nations to avoid their dependence on outside supplies of raw material for their important manufacturing industries. This time it is Italy and the inventor is M. Antonio Ferretti. The raw material used for the purpose is casein, the composition of which so closely resembles that of natural wool that this circumstance led the inventor to the possibility of manufacturing it into the form of a wool substitute. Casein is treated to obtain a solution somewhat like "viscose" which is then passed through twisters with very fine holes, then through a coagulating bath, and later cut into the desired length to obtain a "flock". The external appearance is said to be like first rate merino wool thoroughly washed and carded. In other essential properties also such as elasticity, consistency, the taking of dyes, resistance to the action of water and of caustic alkalies, etc., it is said to compare very well with natural wool; it is warm, soft and non-conducting; it is said to be superior in its smoothness and unshrinkability, though inferior in respect of its felting capacity. Prof. Georges Ray (*Bul. Internat. Inst. Agric.*, April 1936) deals with the possible reactions of this invention both in Italy and elsewhere on the dairy industry in particular and the sheep and cattle raising industries in general.

A. K. Y.

Development of the Embryo Sac in *Gagea* (Liliaceae.)—Romanov (*Planta*, June 1936, Bd. 25, Heft 3), has just published the results of a very thorough investigation on the embryology of three species of *Gagea*, *viz.*, *G. ova*, *G. tenera* and *G. graminifolia*. The results are very interesting, for this genus also now shows the occurrence of the type of embryo sac discovered by Bambacioni (1928) in *Fritillaria persica*. Briefly, the 4 megaspore nuclei formed after reduction are not separated by walls and three of them pass to the chalazal end of the sac. In the third division the metaphasic spindles of these nuclei fuse together so that a second 4-nucleate stage results, in which the 2 micropylar nuclei are haploid, while the chalazal two are triploid. The fourth division occurs in only three of these nuclei; the fourth and lowest usually remains undivided and degenerates. The mature embryo sac thus has 7 nuclei of which 3 form the egg apparatus, one is the upper polar, one is the lower polar ($3n$), and 2 form the antipodals (also $3n$). It is concluded that the type of development shown to occur in *Gagea* indicates that its proper place lies in the group *Tulipeæ* (where a similar embryo sac is known to occur in some other genera) and not in the *Allieæ*.

On p. 453 the author suggests that this type of modification of the embryo sac may henceforth be called the "*Fritillaria*-modification" and the name "*Lilium*-type" be abandoned since it does not exist in *Lilium*. For this should be

substituted the name "*Adoxa*-type", since this was the first genus reported to have an eight-nucleate embryo sac arising from the megaspore mother cell by only three nuclear divisions. An exactly similar opinion has been expressed elsewhere by the present writer.

Maheshwari, P.," Review of D. C. Cooper", *Jour. Ind. Bot. Soc.*, June 1936.

P. MAHESHWARI.

"Fish-Pearls" from the Andamans.—A paper of unusual interest has recently been published in the *Proceedings of the National Institute of Sciences of India* (1936, 2, No. 2, 93–100) in which Dr. H. Srinivasa Rao records the occurrence of pearl-like concretions (Calculi) found in the stomach of cartilaginous and bony fishes from the Andaman sea and gives a fairly detailed account of their physical and chemical properties. The author gives a resumé of the earlier records of "pearls" found in animals other than molluscs, such as fish, crustaceans, etc. and discusses the formation of chitin in the external and internal structures of various animals, in which "pearls" have been found. He concludes that "the chitinous 'pearls' from the Andamans may have been formed in the gall-bladder or in the connective tissue of the liver of the predatory fish or its prey".

Chimpanzee Births in Captivity.—We have no detailed chronological account of the pro-œstrous gestation and parturition phases of the sexual life of the Anthropoids and the paper by J. H. Elder and R. M. Yerkes (*Proc. Roy. Soc. Lond.*, (B), 1936, **819**, 409) considerably fills the large gap in our knowledge of the development of the apes. The authors describe that out of the 15 pregnancies only one chimpanzee happened to give birth to a twin. Impregnation occurs at about the "mid-point of 35-day sexual cycle". Conception ends menstruation and the average duration of gestation is 236 days. The mother is observed to be very docile both during pregnancy and after parturition.

The Spermatogenesis of *Ichthyophis Glutinosus*.—The history of the germ cells of no member of the Apoda is known and B. R. Seshachar in a recent paper (*Zeitschrift. Zell. u. mikr. Anat.*, June 1936, Bd. 24, H. 5, 662) has described the spermatogonia of *Ichthyophis glutinosus*. The testes of the animal are in the form of a varying number of distinct lobes connected together by a longitudinal collecting duct. Each lobe is made up of a number of locules filled with a fatty matrix in which the cells undergoing spermatogenesis are seen scattered in groups. The primary spermatogonia are large cells occupying the mouth of the duct as well as the periphery of the locule. The nucleus, at first spherical, becomes gradually polymorphic as metabolic activities are initiated in the cell. The mitochondria exhibit a characteristic grouping around the archoplasmic area in the form of a concentric ring. The Golgi bodies invest the archoplasmic area, and are in the form of crescentic batonettes. There are 42 chromosomes. The secondary spermatogonia are smaller and occur in groups along the periphery of the locule.

SCIENCE NOTES.

Professor Lidio Cipriani of the Anthropological Institute of the Royal University of Florence left Italy alone in September 1934 on his seventh scientific expedition. He visited Ceylon and South India and concentrated particularly on the peoples of Coorg, Cochin and Travancore. He left India in June 1935 and returned to Italy by car through Baluchistan, Persia, Iraq, Syria, Turkey, etc. Some of his anthropometrical data for a few Coorg communities have now appeared (*Archivo per l'Antropologia e la Etnologia*, **65**, fasc. 1–4, 87–124, 19 figs.). There is a brief discussion of the importance of Coorg anthropologically, and the national dress is described. Maximum, minimum and mean data for height and for three somatic indices are given in one table for 846 individuals in nine different castes and tribes including those for 119 Todas. The samples are rather small for all but "True Coorg" males (287), and the figures for Kadir, Kanikkar and Urali are scarcely statistically significant. The other tables deal with the data for Coorgs, Kurubas and Yeravas only, and two separate communities of each of the latter are treated together. Skin colour shows marked differentiation between the Coorgs and the far darker low-caste people. Interesting graphs show the distribution of stature, skeletal cephalic, facial and nasal indices for males and females of these three castes. The Coorgs are strikingly taller, more brachycephalic and leptorhine. This study avoids the common tendency anthropologists have to concentrate on the rarer Hill Tribes to the neglect of the higher communities on the West Coast. Many Western students are under the impression that this region is inhabited almost entirely by short, dolichocephalic tribes. These data show that the Coorgs are quite tall and definitely brachycephalic with maxima at 79, 81 and 83 for males. Other tables show the correlations between stature, cephalic index and nasal index. The table in which the author compares his results with those of Holland published thirty-five years ago is illuminating because it demonstrates the reliability of the cephalic index and the unreliability of the nasal index for comparative purposes when different workers are involved. There are some excellent photographs.

On this same expedition Professor Cipriani measured 2323 persons, including 737 females. The data were obtained from thirty-seven different castes and tribes; fifty or more of one sex were measured only in the case of Brahmins, true Coorgs, Lingayats, Kembattis, Kurubas, Todas and Yeravas. He was assisted in this work by Dewan Bahadur L. K. Ananthakrishna Iyer, the veteran Anthropologist of India. Prof. Cipriani is now engaged in writing a book on India.

* * *

Royal Asiatic Society of Bengal.—At a meeting of the Royal Asiatic Society, held on 3rd August, Prof. J. N. Mukherjee exhibited a brass utensil pierced by hailstones.

"On the 24th Falgun, 1342 B.S. (8th March

1936), there was a gust of wind accompanied with slight rain which lasted about 10 minutes in the vicinity of Mondalgram, P. S. Satgachia, Dt. Burdwan. It took place at about 7–30 P.M. Next day at 6–30 P.M. there was a severe hail-storm (Nor'wester) in the locality; the unusual feature was the large size of the stones and the velocity with which they came down. Mr. Rabindranath Bhattacharya of the above village, who was returning from a neighbouring village, was caught in the storm and rendered unconscious. On regaining consciousness he attempted to reach the village but swooned again. He was later rescued in time by some men. Gour Bagdi, of village Koshigram, P. O. Nashigram, P. S. Bhatar, Dt. Burdwan, and another person are reported to have died near the same spot. Mr. Bhattacharya states that the stones were about a pound in weight. He tried to protect himself with his umbrella but he fell down and felt as if he had been struck by a log of wood. He was attended to by a medical man of the village, Dr. Anil Mukherjee. He was in a state of stuper till 2 A.M. and had a temperature of 102°. The fever persisted for eight days and he was confined to bed for twelve days. It was reported that brass utensils lying on the shaded verandah of houses in the village were pierced by the hailstones leaving holes as if they were struck by bullets. Raneegunge tile roofs have also been broken through, stones passing into the interior of the house. Palm trees have been denuded of their leaves and barks torn off on the sides on which the stones struck. Corrugated iron roofs of a house were bodily removed. Some of these corrugated iron sheets have been flattened by the impact."

At the same meeting, the following papers were read :—(1) Col. I. Froilano De Mello : "*Further contributions to the study of the blood parasites of the Indian birds together with a list of the Hemoparasites hitherto recorded.*" (2) A. Banerji-Sastri : "*The Nāgas in the 3rd and 4th centuries A.D.*" (3) Sasanka Sekhar Sarkar : "*The Social institutions of the Mālpāhāriās,*" (4) Sayyid Wajahat Husain : "*Āzād Bilgrāmi.*"

The following candidates were balloted for as ordinary members:—(1) Mr. H. C. Mandhata, M.A., (2) Mr. Phanindra Lal Gangooly, M.A., and (3) Dr. Bihali Behari Sarkar, M.Sc. (Cal.), D.Sc. (Edin.), F.R.S.E.

* * *

Early Man in North America.—A joint expedition of the National Geographic Society and the Smithsonian Institution has commenced the search for the remains of the earliest human beings in North America, believed to be Mongoloid ancestors of the American Indian, who migrated across Bering Strait from Asia.

The expedition will also excavate old village sites of prehistoric Eskimos who came to North America from Asia much later than the original arrivals and who were forerunners of the Eskimos of to-day. Buried villages and refuse heaps left by these ancient Eskimos, preserved for centuries in the perpetually frozen soil, are widespread in Northern Alaska.

Many scientists are of the opinion that North and South America must have been populated originally by Asiatics who crossed Bering Strait to Alaska, many centuries before Christ; but so far no relics nor remains of these ancient immigrants have been found.

The project is known as the National Geographic Society—Smithsonian Institution Archæological Expedition to the Bering Sea. Its leader is Henry B. Collins, Jr., of the Smithsonian Institution, who had previously four seasons doing archæological work in the Bering Sea region, and who is an authority on the history and culture of the Eskimo.

The expedition left Washington on May 20. Its headquarters will be at Cape Prince of Wales, westernmost point of North America, only 55 miles across Bering Strait from the mainland of Asia. The party will excavate both along the Bering Sea coast and on one of the Diomedes Islands in Bering Strait, 30 miles from the Asiatic coast, which is under American sovereignty. The other of the Diomedes, 23 miles from Asia, belongs to the U. S. S. R. The International Date Line passes between the American and Russian Diomedes.

Mr. Collins and other archæologists have reconstructed roughly the whole story of the Eskimo's development in North America and the Bering Sea region, pushing back the time of his beginnings to about 1,000 years before Christ.

* * *

Central Poultry Institute.—The Government of India have approved of the scheme for the establishment of a Central Poultry Institute at Izatnagar under the administrative control of the Director of the Imperial Institute of Veterinary Research and have sanctioned a non-recurring expenditure of nearly Rs. 2,75,000, for the construction of buildings and roads and for certain other capital expenditure and an average recurring expenditure of nearly Rs. 56,000 annually, from 1937–38 onwards for the salaries of staff, etc., of the Institute.

The Institute will carry on research on disease, nutrition and genetics of poultry and act as a bureau for the dissemination of the results of research in this and other institutions. It will also carry on investigations on processing and disposal of poultry and egg products and make arrangements for courses of training if there be any demand for them.

* * *

Industrial Research Bureau.—The following statement gives particulars of papers for which the Government of India has awarded prizes.

	Rs.
1. Manufacture of Photographic Plates in India.—N. Kasinathan, M.A., M.Sc., Calcutta	1,000
2. Process for the Preparation of pure Al_2O_3 and SO_2 gas from Bauxite-Gypsum Mixture.—(*a*) Dr. V. S. Dubey, M.Sc., Ph.D., Benares; (*b*) Professor M. B. Rane, M.A., Benares; and (*c*) M. Kanakaratnam, M.Sc., Benares	500
3. Utilisation of Nepheline Syenite Rock.—(*a*) Dr. V. S. Dubey, M.Sc., Ph.D., Benares; (*b*) P. N. Agrawala, M.Sc., Benares	250

	Rs.
4. Losses on Electrical Machinery due to Open Slots.—Kenneth Aston, B.SC., Tech. M.I.E.E., Bangalore ..	250
5. Aromatic Resources of India.—Sadgopal, M.SC., Benares	150
6. Saponification of Mahwa Oil.— R. K. Gobhil, B.SC., A.H.B.T.I., Cawnpore.	150
7. A New Process for the Solvent Extraction of Castor Seed with Rectified Spirits. —Dr. N. G. Chatterji, Cawnpore ..	150
8. The Preparation of New Wetting Agents.—(a) K. Venkataraman, M.A., Ph.D., Bombay; (b) D. R. Dhingra; and (c) I. S. Uppal, Bombay.	150
9. Cashew Nut Shell Oil and its Utilisation.—N. M. Patel, Bombay.	150

* * *

Improved Varieties of Cotton.—The Indian Central Cotton Committee sanctioned a scheme in 1930, for carrying out work at the Experimental Farm at Ganganagar, Bikaner State, for (1) The isolation by means of selection and hybridisation of an improved type of Indian cotton; (2) the production, maintenance and supply of pure seed of the improved type to the neighbouring seed farm for distribution in the Colony; (3) The improvement of the production of raw cotton including cultivation, manuring and the correct adjustment of irrigation water; and (4) The discovery of the best rotation for the cotton including the precise effect on yield and staple of periodical monsoon fallow. A sum of Rs. 52,700 spread over a period of 5 years, was allotted for the scheme. The work was started in January 1931, under the charge of the Director of the Institute of Plant Industry, Indore, and Agricultural Adviser to the States of Central India and Rajputana.

The results so far obtained definitely indicate that *Mollisoni* and *Cawnpore* 520—both deshi varieties of cotton, one from the Punjab and the other from the United Provinces—combine a higher yield per acre with hardiness. *Mollisoni* gives satisfactory yields with even three irrigations when sown in the middle of May or early June, while *Cawnpore* 520 gives the highest yield when it is sown in June.

A seed farm has been established at Sriganganagar for the benefit of agriculturists in the Colony so that these two improved varieties may be perpetuated, and seed will be sold to cultivators by the Bikaner State Department of Agriculture through Tehsil headquarters and cooperative societies, beginning with the 1936 Kharif season.

* * *

Conference on Rural Hygiene.—As a result of the demand of the Indian Delegation to the League of Nations in 1932, a Rural Hygiene Conference will be held in August 1937 in Java, and will deal not only with problems of Public Health but with all the activities covering rural life which tend to raise the standard of living of the rural population. It would consequently, deal with the activities of the agricultural, cooperative and educational departments. The League of Nations appointed a commission with Mr. A. S. Haynes as Chairman and Dr. E. J. Pampana and Professor De Langen as members, to draw up a programme for the Conference. The commission have toured in India, Burma, Malaya, Siam, Indo-China, Philippine Islands, Java and Ceylon and have collected data which will be of value in drawing up the programme.

* * *

German Himalayan Expedition.—Herr Paul Bauer, who led the German Expedition to Mount Kanchengunga in 1929 and 1931, with three companions, Dr. Wien, Herr Hepp and Herr Goettner, have started on a mountaineering trip in Sikkim. The expeditionists intend reconnoitering round about the two peaks, Mount Simu and Mount Sinilchu and part of the Zemu glacier on the eastern side of the Kanchengunga. The party may also attempt to climb some of the unconquered peaks in that region.

* * *

A Natural Cure for Syphilis.—Prof. Dr. Franz Jahnel of the Kaiser Wilhelm Institute, Munich, reports (*Forschungen und Fortschritte*, 1936, 18, 132), some exceedingly interesting results of his work on the cure of syphilis. Besides the usual laboratory experimental animals, some wild animals are susceptible to the disease as for example *Myoxis glis* (German name, Siebenschlæfer). The Syphilis-causing Spirochæta can penetrate even to the brain of this rodent. Prof. Jahnel's experiments bring out the extraordinary fact that a syphilitic *Myoxis glis* is completely cured after its winter-sleep. Prof. Jahnel has established that the cure is not due to any medicament but is a natural phenomenon. He also found that other winter-sleeping rodents were cured of the disease in the same way. The Siebenschlæfer is so named in German because its winter-sleep extends to about seven months in the year. (Sieben = seven and schlæfer = sleeper). It is, of course, well known that the usual "sleep" of the animal is fundamentally different from its "winter-sleep"—a condition of deep consciouslessness from which the animal cannot be momentarily "awakened". The normal body-temperature of *Myoxis glis*, 36°, sinks during its winter-sleep to about 4° and sometimes to fractions of a degree above 0°. During this period the animal breathes only in intervals which are of not less than 15 minutes' duration. It takes, needless to say, no food during these seven months. It can however be awakened from its winter-sleep by being kept in a warm room for about 1–2 hours when it resumes its normal physiological functions. Prof. Jahnel's experiments proved conclusively that Syphilis-infected animals which completed their winter-sleep normally were found to be free from the spirochæta while in infected animals which were artificially prevented — by being kept in a warm room — from having their winter-sleep, no cure was effected.

Further work is in progress at the Munich Institute to elucidate the exact mechanism of this phenomenon. It is still an open question whether the low body-temperature over a long period and the minimisation of the assimilation processes have any curative effect. It is, however, noteworthy that a "hunger-cure" for Syphilis was often prescribed in the Middle Ages. Prof. Jahnel's work opens a new and hopeful chapter in the grim fight against the disease and reveals a vista full of possibilities.

Microchemistry in Czechoslovakia.—A Czechoslovakian Microchemical Society was founded on April 25, in Prague at a gathering of about two hundred chemists, from both Czech and German scientific and industrial circles. Professor J. Heyrovsky, Professor of Physical Chemistry at the Charles University, known for his microchemical polarographic studies, has been elected president. The Society's activities were inaugurated by a lecture by Dr. C. J. Van Nieuwenburg, Professor of Analytical Chemistry in the Delft Technical High School, on "Why and Where Microchemistry"? Austrian microchemists were represented by Professor Fritz Feigl, Professor of Chemistry in the University of Vienna. The new Society intends to cooperate with microchemical societies and clubs of England, America, Holland and Austria with the view of establishing an International Microchemical Society. The official title of the Society is "Societas miccrochemica C. S. R.," and its address, Prague, II, Albertov 2030.—(*Chemical Age*, 1936, **35**, 39).

* * *

Institute for the Study of Animal Behaviour.—With the object of promoting and encouraging research into animal behaviour, the British Institute has recently been inaugurated. It is hoped to issue to members a quarterly Bulletin in which will be provided summaries of papers of the general work being done in the various branches of the subject. Meetings for the transactions of scientific business will also be held at intervals. Prof. Julian S. Huxley has been elected as the President. Further information can be had from the Hon. Secretary, R. C. Oldfied, The Psychological Laboratory, Cambridge.

* * *

National Institute of Sciences of India.—At the Ordinary General Meeting of the Institute, held at Simla on Sunday the 19th July, with Brigadier H. J. Couchman in the chair, the Secretary announced the following donations :—

Tata Iron and Steel Co., Ltd.	..	5000
H. H. Maharaja Holkar of Indore	..	2000
Dr. S. C. Law	..	2000

* * *

The National Academy of Sciences, India.—The following has been elected Members of the National Academy of Sciences, India :—(1) Mr. A. T. Dharma Dass, Allahabad; (2) Mr. G. P. Pendse, M.Sc., Gwalior.

* * *

The Mining and Geological Institute of India.—The annual meeting of the Mining and Geological Institute of India was held in the buildings of the Asiatic Society of Bengal on 3rd February 1936. After transacting the usual formal business, the new president Dr. C. S. Fox (*Transactions of the Mining and Geological Institute of India*, **31**, Pt. 1) delivered a very interesting address on the growth and development of the Geological Survey of India. The annual dinner was attended by many members and the Hon. Sir F. Noyce was the chief guest. During the year under report several excursions were held for members to such interesting places as Raniganj and Jharia coal fields.

* * *

Sir Henry Wellcome.—Death occurred of Sir Henry Wellcome, Doctor, Scientist and Explorer on July 25.

He was the Governing Director of the Wellcome Foundation and Director of the Wellcome Historical Medical Museum, London. Sir Henry led an Expedition to the Upper Nile regions of the Anglo-Egyption Sudan in 1901 for archæological and ethnological explorations which he resumed and continued in and after 1910 discovering a number of ancient Ethiopian archæological sites. He was a pioneer in aerial photography which he employed in his exploration work. During the Great War he placed the services of the Wellcome Bureau of Scientific Research and its staff at the disposal of the Government and instituted a special commission to secure improvements in design and construction of field ambulances in 1914 and constructed, equipped and supplied for the British Army Medical Service a chemical and bacteriological motor field research laboratory which was in Palestine during the War.

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Dr. L. C. Verman has been appointed Research Officer, Industrial Research Bureau.

* * *

Prof. Dr. Max Born, has been appointed Professor of Natural Philosophy, University of Edinburgh, as successor to Prof. C. G. Darwin. Prof. Born will be taking charge of his duties at the University from the 1st October.

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Dr. W. Burns, Director of Agriculture, Bombay Presidency, has been appointed Officiating Agricultural Expert, Imperial Council of Agricultural Research.

* * *

International Geological Congress, Moscow, 1937.—Mr. D. N. Wadia of the Geological Survey of India, has been invited by the Organising Committee of the XVII International Geological Congress to be held in Moscow in 1937 to give a report to the Congress on "The Tectonics of North India".

* * *

Dr. Frederick George Novy, former Professor of Bacteriology and Dean of the Medical School of the University of Michigan, was awarded the 250,000th microscope produced by Bausch & Lomb at a luncheon tendered to members of the American Association for the Advancement of Science during its summer sessions at Rochester, New York.

Dr. Novy was selected for this honour by the Executive Committee of the A.A.A.S. for outstanding research in the field of bacteriology and immunology. He discovered and isolated the *Bacillus* Novyi, the agent of gas gangrene; was the first to culture *Trypanosoma* Lewisi, and is the discoverer and isolator of *Spirochæta* Novyi, the cause of American relapsing fever. He has also made notable contributions to the study of filterable viruses, the respiratory processes of bacteria, and the causes of diphtheria, yellow fever, and bubonic plague. A student of both

Koch and Pasteur, Dr. Novy has the distinction of being the only person in America to-day who studied under Pasteur. France has paid him homage by making him a Chevalier of the Legion of Honour; Czechoslovakia created him a member of the Order of the White Lion, and Sinclair Lewis has romanticized him in his book, *Arrowsmith*. For nearly fifty years, Dr. Novy was a member of the Medical Faculty of the University of Michigan, and is almost the last of the distinguished group gathered by the late Dean Victor C. Vaughan.

Dr. Novy's address at the luncheon on "Some Results of Microscopic Research of Specific Significance for Human Welfare," was preceded by brief addresses by Dr. Edwin G. Conklin, President of the A. A. A. S., Herbert Eisenhart, President of Bausch & Lomb, and Dr. Edward Bausch who presented the 250,000th microscope of the Company. It was Dr. Bausch's fifty-ninth year as a member of the A. A. A. S. and the first time the Association had met in Rochester since 1892.

* * *

Applications are invited for the posts of :—(1) Professor of Physics, Murari Chand College, Sylhet; salary Rs. 250–50–300 (on confirmation) 40/2–500–50/2–800. Apply to R. C. Ray Ghatak, Esq., Personal Assistant to the Director of Public Instruction, Assam; (2) Circle Inspector of Schools in the United Provinces: pay Rs. 300–25–500–50–600–30–900–50–1,000. Apply to Director of Public Instruction, U.P., Allahabad. Last date for application, September 7.

Applications have been called for admission to the Jamshedpur Technical Institute from Indians who wish to take up a career at the Company's Works at Jamshedpur and who possess a degree or diploma in Mechanical or Electrical Engineering or Metallurgy (Class B), or an Honours or First Class Degree or diploma in the same subjects (Class A-1) preferably accompanied by works experience abroad, or an honours or first class degree or diploma in these subjects accompanied by not less than six months conspicuous practical experience after graduation in an Iron and Steel Works abroad. The age of any candidate on 31st December 1936 must not exceed 27 years in the case of graduates from foreign Universities and 24 years in the case of graduates from Indian Universities.

A combined theoretical and practical training of two years' duration is given at the Institute and in the Works of the Company. Apprentices of Class A (2) will be paid Rs. 200 per month throughout 2 years. Laboratory work will not be counted as Works experience. Other apprentices will receive Rs. 75 per month during the period of their apprenticeship in Class A (1) or Rs. 50 per month in Class B. Intending candidates should apply to the Superintendent of Training, The Technical Institute, Jamshedpur, *via* Tatanagar, B. N. Railway, for the necessary forms, which must be completed and returned to him by September 15, 1936.

* * *

Announcements.

The 11th International Congress of Psychology will be held at Madrid on September 6–12 under the presidency of Prof. E. Mira of Barcelona. Further information can be had from the General Secretary, Dr. José German, Instituto Nacional di Psicotecnica, Alberto Aquilera 25, Madrid.

Conference on Educational Broadcasting.—The first Conference on Educational Broadcasting will be held in December 1936, from Thursday 10th to Saturday 12th, at Washington D. C., in co-operation with the Federal Communications Commission and the United States Office of Education. A group of organisations representing every phase of American education, has arranged the Conference.

The purpose of the Conference is to enable the large number of persons who are interested in educational broadcasting to discuss means by which radio may become a more effective instrument for education, both formal and informal; to serve as a clearing house for information on the latest technical and professional developments in educational broadcasting; and to enable persons representing all phases of the subject to become acquainted and to exchange ideas and experience.

All organisations and all persons interested in radio as a social and educational force are invited to attend and participate.

Further information regarding the Conference can be obtained from Mr. C. S. Marsh, Executive Secretary, 744, Jackson Place, Washington D.C., U.S.A.

Scientific Studies in Germany.—The Consul-General for Germany advises Indians to give timely warnings of their proposed visits to scientific research institutions in Germany so as to avoid disappointment. The Consul-General writes: "A great number of foreigners interested in scientific research work have of late applied directly and also on very short notice to the heads of Government Colleges and Research Institutes in Germany for permission to visit their institutions. Although there are no objections against such visits my Government would much appreciate if an intimation of such contemplated visits would reach them in time by way of the usual diplomatic channels. Following that procedure applicants will avoid the risk of being disappointed in case the institutions under reference are closed on account of rebuilding, personnel changes or other reasons."

Uses for Glue.—The "Epidos" Association has set aside a certain sum for the purpose of encouraging research by those who will put forward interesting ideas for the use of glue, and also recompensing those with proposals already ripe for development.

The General Secretariat of the International Association, at 40, Rue du Colisée, Paris, is prepared to furnish all information on this matter to any person desirous of submitting a proposition for a new use or the improvement of an existing use for bone-glue.

A competition was held some time ago by the "Epidos" International Association of Bone-Glue Manufacturers with the object of stimulating and rewarding research for the increase and improvement of outlets for bone-glue. This competition aroused considerable interest among all kinds of research workers, and several promising ideas were put before the Association. A total sum of 30,000 Swiss francs was distributed to the winners of this competition.—(*Chemistry and Industry*, 1936, **55**, 548).

J. M. Das Gupta Memorial Medal.—Applications are invited for the above Gold Medal for 1936 from Research Chemists of any age. The award will be made on unpublished researches and on independent papers published in the *Journal of the Indian Chemical Society* by the candidates during the years 1935 and 1936. Application together with four copies of reprints or typewritten papers should reach the Hon. Secretary, Indian Chemical Society, 92, Upper Circular Road, Calcutta, *not later than 30th September* 1936 from whom also relevant rules guiding the award can be had.

University of Bombay.—The Department of Chemical Technology is offering three prizes of Rs. 250, 125 and 75 for the best textile designs. The designs containing not more than three colours suitable for roller printing on textile fabrics should be submitted before November 30, 1936. A special 'Endeavour' prize of Rs. 150 will be awarded for the most original and practical design. Full particulars and entrance forms may be had from Dr. R. B. Forster, A.R.C.S.I., Ph.D., D.Sc., F.I.C., Head of the Department.

We acknowledge with thanks, receipt of the following:—

"Nagpur Agricultural College Magazine," Vol. X, No. 4, May 1936.

"The Agricultural Gazette of New South Wales," Vol. XLVII, Part 7, July 1936.

"Journal of Agricultural Research," Vol. 52, Nos. 8–11.

"Indian Journal of Agricultural Science," Vol. IV. Index.

"Monthly Bulletin of Agricultural Science and Practice," Vol. 27, Nos. 5 and 6.

Department of Agriculture, Dominion of Canada:—Technical Bull. No. 4, "Taxation in Rural Ontario". Circular No. 93, "Take-all-A Root-rot of Cereal Crops". Bulletin No. 4., "Medicinal Plants and Their Cultivation in Canada".

"Journal of Agriculture and Livestock in India," Vol. VI, Part III, May 1936; and Index to Vol. IV, 1934.

"The Philippine Agriculturist," Vol. XXV, No. 2, July 1936.

"Journal of the Royal Society of Arts," Vol. LXXXIV, Nos. 4361–4364.

"Biological Reviews," Vol. II, No. 3, July 1936.

"Communications from the Boyce-Thomson Institute," Vol. 8, No. 1, Jan.—March—1936.

"The Calcutta Review," Vol. 60, Nos. 1 and 2, July and Aug. 1936.

"Chemical Age," Vol. XXXIV, Nos. 886–889.

"Journal of Chemical Physics," Vol. 4, Nos. 6 and 7, June and July 1936.

"Journal of the Indian Chemical Society," Vol. 13, No. 5, May 1936.

"Berichte der Deutschen Chemischen Gesellschaft," Vol. 69, No. 7.

"Russian Journal of General Chemistry," Vol. VI, Nos. 5 and 6.

"Journal de Chemie Physique," Vol. 33, Nos. 6 and 7.

"Journal of Entomology and Zoology," Vol. 28, No. 2.

"Experiment Station Record," Vol. 74, No. 6, June 1936.

"Transactions of the Faraday Society," Vol. XXXII, No. 7, July 1936.

"Indian Forester," Vol. LXII, Nos. 7 and 8, July and August 1936.

"Indian Forest Records," Vol. II, Part 6. Entomology: Zwei Neue Callirrhipis mit ihren Larven. *Saudalidæ*, wt.) by Fritz Van Emden, Dresden.

"Forschungen und Fortschritte," Vol. 12, Nos. 18–21.

"Genetics," Vol. 21, No. 4, July 1936.

"Indian Trade Journal," Vol. CXXII, Nos. 1568–1572.

"Journal of the Indian Mathematical Society," Vol. II, No. 2, 1936.

"The Calcutta Medical Journal," Vol. 31, No. 1, July 1936.

"Medico-Surgical Suggestions," Vol. 5, No. 6, June 1936.

"Review of Applied Mycology," Vol. 15, No. 6, June 1936.

"Indian Science Abstracts," 1935, Part I, (National Institute of Sciences, India, July 1936).

"Indian Association for Mental Hygiene" (Calcutta, Quarterly Bulletin No. 31, July 1936).

London Shellac Research Bureau: "Plasticising Lac Films," Part I.

"Journal of the Osmania University," Vol. II, 1934.

"Journal of the American Museum of Natural History," Vol. 37, No. 6, June 1936.

"Nature," Vol. 137, Nos. 3477–3480; Vol. 138, No. 3481 and Index to Vol. CXXXVII, Jan. 1936–June 1936.

"Journal of Nutrition," Vol. 11, No. 6, and Vol. 12, No. 1,

"Science and Culture," Vol. II, Nos. 1 and 2.

"Lingnan Science Journal," Vol. 15, No. 2, June 1936.

"Science Progress," Vol. 31, No. 121, July 1936.

"Scientific American," Vol. 155, No. 1, July 1936.

"Mysore University Calendar for 1935–38," Vol. I, and Supplement to 1934–35.

"Indian Journal of Veterinary Science and Animal Husbandry," Index to Vol. IV.

Catalogues:

"4 Neuerscheinungen, Physiologie-Physiologische Chemie" (Messrs. Walter de Gruyter & Co., Berlin).

"Monthly List of Books on Natural History and Science" (Messrs. Wheldon and Wesley, Ltd.).

ACADEMIES AND SOCIETIES.

National Institute of Sciences of India:

July 19, 1936.—P. B. SARKAR: *On the Constitution of Fluoroform, Chloroform, Bromoform and Idoform and the Part Played by Prototropic Changes in the Reactions of These Substances.* J. B. LAL: *On the Colouring Matter of* Nyctanthes arbortristis, (commonly known as *Harsinghar* in Hindusthani and *Shieuli* in Bengali).—The flowers give a beautiful but fleeting yellow dye which still finds limited application for dyeing silk in Northern India. The name Nyctanthin was given by Hill to this colouring matter. A. G. Perkin identified it with the colouring matter from Indian Mahogany. Kuhn suggested on the basis of his observations that α-quercetin is identical with Nyctanthin. This suggestion is confirmed by further experiments. N. CHOWDHURY: *Notes on Some Indian Species of* Lycopodium *with Remarks on the Distribution of the Genus in India.*—An account of the genus *Lycopodium* from the points of view of its distribution, anatomy, modes of vegetative propagation and epidermal structure. J. N. MUKHERJEE and M. C. CARBERY reported that clay pans which impede drainage and prevent the penetration of root systems of such cultivated plants, *e.g.*, sugarcane, have been observed in the Barisal Farm in the Bakerganj District of Bengal. They occur about 7″–9″ below the surface and appear to be extensive and to arise out of the special properties of the clay. Work is being carried out at the Bengal Government Farm at Dacca and some associated colloidal studies will be made in the physical chemistry laboratory of the Calcutta University. J. N. MUKHERJEE presented a summarised account of investigations in his laboratory carried out by Messrs. S. P. Roy Chowdhury, R. P. Mitra, S. Mukherjee, B. Chatterjee and H. K. Sen, during the last six years on the electro-chemical properties of acids in a colloidal state. Pure substances as well as hydrogen clays separated from soils have been examined. The results show definitely that the total acidity of such systems depend on a number of factors of which a regular and a specific or irregular cation effect discovered as a result of these investigations are of great theoretical and practical interest both from the point of view of colloidal science and of its applications, *e.g.*, to soil science. The determinations of exchangeable bases, of the base saturation capacity, of the degree of saturation of the soil and of the soil absorbing complex are carried out on a more or less empirical basis. The investigations carried out with the help of a grant from the Imperial Council of Agricultural Research and of the University of Calcutta provide a basis for a theoretically satisfactory treatment of these subjects. The electrical double layer and the absorption of ions play a very important rôle which is responsible for their properties which render the classical concepts of electro-chemistry inadequate for their theoretical treatment. P. N. GHOSH: *The Distribution of Ultra-Violet Intensity in the Sunlight at Calcutta during the Year* 1931–32.—The subject has great practical value in connection with that branch of applied science known as illumination engineering. Data of the type are unavailable in India. L. A. RAMDAS and R. K. DAVID: *Soil Temperatures.*—Results of experiments carried out at the Central Agricultural Meteorological Observatory at Poona during the last two years to measure the various factors which determine the thermal balance at the earth's surface were presented. Experiments have also been made on the effect of covering the local soil with thin layers of chalk and of typical Indian soils on soil temperatures. The effect of wetting the soil surface and that of a layer of vegetation on soil temperatures have also been investigated. These show that soil temperature can be controlled to a large extent by suitably altering the nature of the surface. Soil temperature in blocks of typical Indian soils when exposed to identical weather factors at Poona show very interesting variations from those in the local soil. These carefully planned experiments are being continued as they are of fundamental interest both to the meteorological and to the agricultural worker. D. L. SEN and DR. NAZIR AHMED in a joint paper described the results of an investigation carried out to find the effect of fertilisers, on the yield, physical properties, chemical constitution and spinning quality of Cambodia cotton. The cotton was grown in adjacent blocks on two types of soil, one naturally fertile which gave a high yield, without any fertilisers, the other rather poor which gave a low yield when no fertilisers were applied. On naturally fertile soil there was no marked difference with regard to the yield and the spinning quality of the cotton with or without any fertilisers. But on

poor soil, not only was the yield profesu but spinning strength of cotton was also higher as a result of the application of fertilisers. The use of fertilisers was found economical when the field is deficient in the elements required by the plant.

Indian Academy of Sciences:

July 1936.—SECTION A.—B. Y. OKE: *Lattice-Theory of Alkaline Earth Carbonates. Part I.—Lattice-Energy of Crystals of Aragonite Type and their Thermo-Chemical Applications.*—Calculations have been made for Aragonite, Strontium Carbonate and Barium Carbonate. The lattice-energy values are verified by a thermo-chemical cyclic process. K. S. GURURAJA DOSS AND B. SANJIVA RAO: *Ageing of Surfaces of Solutions. Part I.—The Study of Variation of Surface Tension of Solutions with Time by the Ring Method.*—It is shown that the ring method is not suitable for the measurement of variation of surface tension with time. S. PARTHASARATHY: *Dispersion of Acoustic Velocity in Organic Liquids.* No dispersion could be detected. K. S. GURURAJA DOSS: *Collision Frequency in Solutions.*—The expressions obtained on the basis of Wheeler's theory of liquids are similar to those obtained by other methods. P. RAMA PISHAROTY: *On the Visibility of Ultrasonic Waves.*–It is suggested that the visibility is due to the amplitude changes brought about by the propagation of a purely corrugated wave-front. S. RAMACHANDRA RAO: *Magnetism and Cold-Working in Metals. Part I.—Polycrystals.*—As a result of cold-working, the diamagnetic susceptibility of bismuth is lowered effectively, while zinc and cadmium show a small decrease. These changes are explained in the light of the existence of distorted layers between the small crystals and of the author's work on metallic colloidal powders. K. NEELAKANTAM AND T. R. SESHADRI: *Pigments of Cotton Flowers. Part III. Karunganni* (Gossypium indicum). S. PARTHASARATHY: *Ultrasonic Velocities in Organic Liquids. Part V.—Some Related Groups.* B. SUNDARA RAMA RAO: *Studies on the Anisotropy of the Optical Polarisation Field in Liquids. Parts IV and V.*—From change of refractivity with temperature, the course of ratio p_2/p_1 which is a measure of the anisotropy of the optical polarisation field is followed. R. ANANTHAKRISHNAN: *The Raman Spectra of Some Boron Compounds (Methyl Borate, Ethyl Borate, Boron-Tri-Bromide and Boric Acid).*—It is found that previously reported frequencies require considerable revision. R. ANANTHAKRISHNAN: *The Raman Spectrum of Cyclo-Propane and Ethylene Oxide.*—Cyclo-propane has been investigated both in the liquid and in the vapour states. M. V. NABAR AND T. S. WHEELER: *The Kinetics of Heterogeneous Organic Reactions (II): The Reaction between Benzyl Chloride and Solid Silver Nitrate in the Presence of Inert Diluents.*—The inhibiting effect of the diluents may be due to absorption on the surface of Silver Nitrate. K. S. GURURAJA DOSS: *Ageing of Surfaces of Solutions. Part II.—Activated Accumulation of Solute Molecules.*—The postulation of activation is very helpful in understanding (*a*) the time of variation of surface tension, (*b*) the high temperature coefficient, and (*c*) the manifestation of surface pressure. K. L. RAMASWAMY: *Di-electric Co-efficients of Gases and Vapours. Substituted Methanes and Ethane, Cyclopropane, Ethylene Oxide and Benzene.*—Sixteen gases and vapours have been studied. K. C. PANDYA AND T. A. VAHIDY: *The Condensation of Aldehydes with Malonic Acid in the Presence of Organic Bases. Part V.—The Condensation of Anisaldehyde. Part VI.—The Condensation of* p-*Hydroxy Benzaldehyde.*

July 1936.—SECTION B.—V. RAMANATHA AYYAR AND R. BALASUBRAMANIAM: *Inheritance of Certain Colour Characters in Gram* (Cicer arietinum).—Modes of inheritance in three types of flower colours and thirteen types of seed-coat colours in gram have been studied in crosses between pure lines at Pusa and Coimbatore. MAKUND BEHARI LAL: *A New Species of the Genus* Parorchis *from* Totanus hypoleucos, *with Certain Remarks on the Family Echinostomidæ.*—A number of parasites from the cloaca of the common summer snipe, *Totanus hypoleucos* have been described. M. S. RANDHAWA: *Occurrence and Distribution of the Freshwater Algæ of North India.*—The results of an ecological survey of the freshwater algæ of Northern India are reported. MAKUND BEHARI LAL: *A New Genus of Trematodes of the Sub-Family Typhlocœlinæ from the Shoveller Duck,* Spatula clypeata. PRAKASH CHANDRA JOSHI: *Anatomy of the Vegetative Parts of Two Tibetan* Caryophyllaceæ—Arenaria musciformis *Wall. and* Thylacospermum rupifragum *Schrenk.*—The internal anatomy and development of the plants which are quite peculiar in their habit and habitat have been described.

National Academy of Sciences of India:

July 29, 1936.—SHUKLA: *Differentiation of a Definite Integral with Respect to a Parameter in Certain Cases when Leibnitz's Rule is Not Applicable.* BHOLANATH SINGH AND P. B. MATHUR: *Apparatus for the Measurement of Respiratory Quotient in Plants.* A. N. PURI: *An Anomaly in the Elastic Behaviour of Indian Rubber.* A. C. ROY: *The Diazo-Compounds of Morphine.* A. C. CHATTERJI: *A Note on the Influence of Lyophilic Colloids on the Wettability of Naphthaline.* A. C. CHATTERJI: *The Numerical Value of Traube's Factor from Wettability Data.* M. P. GUPTA AND JAGRAJ BIHARI LAL: *Chemical Examination of the Seeds of* Physalis peruviana *or Cape Goose Berry.* R. K. CHATTERJI AND S. DUTT: *Chemical Examination of Oils from the Seeds of* (*a*) Crotolaria Medicagenea, (*b*) Cassia Occidentalis. L. D. TEWARI AND S. DUTT: *Dyes derived from* 3 : 4 : 3′ : 4′-*tetraamido-diphenyl.* B. B. BISWAS AND S. DUTT: *Constitution of Fluoranthrenequinone and its Derivatives.*

Indian Association for the Cultivation of Science:

July 1936.—B. C. MUKHERJEE: *On the Linearity of Lorentz Transformation.* D. P. RAY-CHAUDHURI and P. N. SEN GUPTA: *Studies on*

Constant Paramagnetism, Part I. D. P. RAY-CHAUDHURI AND P. N. SEN GUPTA: *Studies on Constant Paramagnetism, Part II.* SUDHENDU BASU AND M. HUSSAIN: *X-Ray Studies on Electro-Deposited Silver.* V. T. CHIPLONKER: *The Rault Depression in Ordinary and Heavy Water.* N. R. TAWDE, S. A. TRIVEDI AND J. M. PATEL: *Ultra-Violet Content of Sunlight at Bombay.* G. N. BHATTACHARYA: *Studies on Some Indian Vegetable Oils, Part II.—Dielectric Constant and Electric Moment.* K. K. ROY: *On An Estimation of Service Area of the Calcutta Station.* S. C. DHAR: *The Study of the Duration of Contact of Pianoforte String with a Hard Hammer Striking Near the End.* JAGANNATH GUPTA: *On the Polarisation of Raman Lines of Formic Acid and Formate and Trichloracetate Ions.*

Indian Chemical Society:

May 1936.—B. B. DEY AND (MISS) P. LAKSHMI KANTAM: *Studies in the Cotarnine Series. Part VI.—Condensation of Cotarnine with Phosgene.* ABANI K. BHATTACHARYA: *Influence of Dilution on the Molecular Refractivities of Complex Cyanides and Cobalt Amines.* J. K. CHOWDHURY AND T. P. BARDHAN: *Measurement of Molecular Areas of Cellulose from Different Sources by Surface Tension Method—Part II.* PARES CHANDRA BANERJEE: *Use of Vanadous Sulphate as a Reducing agent. Part II.—Estimation of Chlorates, Nitrates and Persulphates.* HIRENDRA NATH DAS-GUPTA: *Studies in Organo-Arsenic Compounds—Part III.* SHRIDHAR SARVOTTAM JOSHI AND P. N. PANIKKAR: *Studies in the Coagulation of Colloids. Part XII.—'Zonal Effect' in the Change of Refractivity during Mutual Coagulations.* SHRIDHAR SARVOTTAM JOSHI AND S. JAYA RAO: *Studies in the Coagulations of Colloids. Part XIII.—'Zonal Effect' in the Opacity Changes in the Coagulation of Colloid Manganese Dioxide.* M. GOSWAMI AND B. C. DAS-PURKAYASTHA: *Analytical Uses of Nessler's Reagent. Quantitative Estimation of Monosaccharides and Disaccharides. Estimation of Furfural—Part II.* RANJIT GHOSH: *Syntheses in Furan Series. Part I.—Synthesis of 2-Ketotetrahydrofuran-4-acetic Acid.* S. S. BHATNAGAR AND N. G. MITRA: *A Critical Examination of Pascal's Value for the Magnetic Susceptibility of the CH_2-Group.* (MISS) B. N. KATRAK: *Preparation of Compounds Related to Phenacetin.* B. B. DEY AND T. K. SRINIVASAN: *Studies in the Cotarnine Series. Part VII.—Action of Sulphuric Acid on Cotarnine, Formation of Methylene-*bisphenol*-betain of 2-Methyl-6 : 7-dihydroxy-8-methoxy-3 : 4-dihydro*isoquinolinium *hydroxide.*

Meteorological Office Colloquium, Poona:

7-7-1936. Dr. S. R. Savur.—"A new method for analysing rainfall suggested by Crowe."

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Muslim University, Aligarh:

Sir Shafaat Ahmad Khan, Kt., D.Litt., of Allahabad University has been co-opted a member of the Executive Council of the University.

At a meeting of the Executive Council of the University, held on the 25th July, the Vice-Chancellor reported that he received a letter from Sahebzada Shahzad Ahmad Khan Saheb informing the University that the late Sardar Sahebzada Sir Sultan Ahmad Khan gave a donation of Rs. 50,000 to the University. The Council gratefully recorded the donation and decided to commemorate the name of the late Sardar Sahebzada Sir Sultan Ahmad Khan in a suitable manner. It was also decided that this amount be put in reserve fund and earmarked for the development of the Department of Technology.

University of Calcutta:

Mr. Nai Aree Supol, a representative of the Government Laboratory, Siam, will shortly visit the University College of Science, Calcutta, to acquaint himself with spectrographic research. Prof. P. N. Ghosh has kindly offered to provide necessary facilities to Mr. Supol.

Mr. C. F. Ball, M.A., and Dr. R. B. Lal, M.B.B.S., D.P.H., D.T.M., have been nominated ordinary Fellows of the University.

A committee has been set up with Dr. T. P. Neogi, Minto Professor of Economics, University of Calcutta, as Secretary, to help students intending to sit for the I.C.S. examination, in their choice of subjects, and to suggest the books they should study and direct them to specialists who would give them necessary guidance in their studies.

The Syndicate has recommended to the Senate to accept with thanks the generous offer of Mrs. Biva Mukherjee, who intends to make over to the University a sum of Rs. 23,000 in cash, in memory of her husband Captain Kalyan Kumar Mukherjee, for creating an endowment for the award of a scholarship for the promotion of Medical Research.

Dacca University.

At the annual convocation held on 28th July, the following honorary degrees were conferred:

Doctor of Laws: H. E. Sir John Anderson, Governor of Bengal and Sir Abdur Rahim, President of the Legislative Assembly; *Doctor of Science*: Sir P. C. Ray and Sir J. C. Bose; *Doctor of Literature*: Dr. Rabindranath Tagore, Sir M. Iqbal, Sir Jadunath Sarkar and Sarat Chandra Chatterjee.

University of Mysore:

The M.A. and M.Sc. degree examinations were held in July 1936.

The programme of Extension Lectures for 1936–37 has been drawn up. A list of lectures which are definitely accepted will be published as soon as practicable.

His Highness the Maharaja Scindia of Gwalior paid a visit on the 25th July 1936 to some of the University Institutions in Mysore.

"Pamparamayana Sangraha" a Kannada publication of the University, was issued during the month.

Mr. Charles Pitchamuthu, Assistant Professor of Geology, was conferred the (research) degree of Ph.D. by the University of Glasgow and elected a Fellow of the Royal Society of Edinburgh.

University of Madras:

Mr. H. Chennakesava Ayyangar, M.O.L., who has been appointed Senior Lecturer in Kanarese in the Oriental Research Institute of this University, joined duty on the 1st August 1936.

The following candidates have been declared qualified to receive the Degree of Master of Science :—

1. Mr. R. L. N. Ayyangar, B.Sc., Thesis—"Variations in the measurable characters of Cotton Fibres".
2. Mr. D. Ganesan, M.A., thesis—(*a*) "A contribution to the Life-History of *Pedalium Murex* Linn."; (*b*) 'Cytological Studies in a Chromosome Ring-forming Diploid *Notonia grandiflora*, D.C."; (*c*) "On the 'Split' appearance of chromosomes photographed with Infra-Red Rays".
3. Mr. K. S. Subrahmanyan, B.Sc., Thesis—"The Occurrence of furan derivatives in volatiles and attempts at synthesis of Isoasarone".
4. Miss Rachæl P. John. Thesis–"The Seasonal Succession and Algal Ecology of a Permanent Pool in Madras."

Osmania University:

Personnel.—Dr. A. H. Mackenzie, M.A., D.Litt., C.S.I., C.I.E., having gone home on leave, Prof. Quazi Mohamad Husain, M.A. (Cantab.), Head of the Department of Mathematics, is officiating as Pro-Vice-Chancellor.

Science Congress Session.—The University has invited the Indian Science Congress Association to hold its next session (24th session) at Hyderabad in the first week of January 1937 and has sanctioned a liberal grant to meet the expenses. Persons of all classes in Hyderabad are joining the local Reception Committee and co-operating with the University authorities to make the forthcoming session a success. A number of sub-committees are working out details with regard to the various activities of the session. It is contemplated to accommodate all the delegates in the newly built hostels of the University, which possess all the conveniences of a modern high-class boarding house. Lodging will be free. Catering will be provided for European, Indian non-vegetarian, South Indian vegetarian and North Indian vegetarian foods and boarding will be charged at actual cost. No charge will be made for service. It is expected that about four hundred delegates will attend the forthcoming session.

Erratum.

Current Science, Vol. V, No. 1, July 1936. page 19, Left-hand Column, line 21, *for* "action," *read* "cation".

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CURRENT SCIENCE

Vol. V] September 1936 [No. 3

Archæology in India.

INDIAN archæological remains can be traced back to the Early Stone Age—as far, that is to say, as those of any country in the world. But in spite of the work that has in comparatively recent times been done upon them their interpretation remains, for the most part, almost as great a mystery as ever. And this applies not only to remains belonging to the far distant prehistoric past, but also to most of the temples of historical times, many of them buildings of great magnificence and many still used for worship. Only here and there has a little bit of the curtain been raised, revealing glimpses of intense interest with all sorts of fascinating possibilities beyond.

Starting with prehistoric and protohistoric times, the collections made by J. W. Breeks in the Nilgiri Hills (added to the collections of the Madras Museum as long ago as 1879), by R. Bruce-Foote in South India generally and by Alexander Rea at Adichanallur in the Tinnevelly District and at Perumbair and Pallavaram in the Chingleput District, have long been well known from published accounts of them containing descriptions and illustrations.[1] But such descriptive accounts are only a beginning—a basis for subsequent interpretation. And though the remains are sufficiently abundant no satisfactory basis for such interpretation is yet available. It seems extremely probable however, that as regards the Stone Age the collections recently made by the Yale-Cambridge Expedition to north India will at last provide one. The importance of their work has already been to some extent indicated to readers of *Current Science* in articles by Drs. de Terra and Hutchinson and by Prof. Sahni. From the side of anthropology, hints as to the racial elements that may have to be connected with these and other remains have recently been provided

[1] "An Account of the Primitive Tribes and Monuments of the Nilgiris" by J. W. Breeks (India Museum, London, 1873; Wm. H. Allen & Co.); "Catalogue of Prehistoric Antiquities" by R. Bruce-Foote (Govt. Mus., Madras, 1901); "The Foote Collection of Indian Prehistoric and Protohistoric Antiquities" by R. Bruce-Foote (Govt. Mus., Madras; "Catalogue Raisonne", 1914 and "Notes on their Ages and Distribution", 1916); "Catalogue of Prehistoric Antiquities from Adichanallur and Perumbair" by Alexander Rea (Govt. Mus., Madras, 1915).

by Guha[2] and Eickstedt,[3] the latter drawing on literary and other evidence to attempt a much more detailed but, it is to be feared, also a much more speculative analysis than the former, which is based more exclusively on anthropometrical investigations. Though the conclusions arrived at by these authors are by no means identical, a certain underlying parallelism between them suggests that they at least provide a good basis for further research, which should lead before long to well-established results.

In comparatively recent years archæologists have been startled by the discovery, through excavations in the Indus Valley, of a great civilisation the very existence of which no one had previously suspected.[4] And it now seems probable that this civilisation was by no means confined to the valley in which it was first discovered, so that the familiar term "Indus Valley Civilisation" is likely to prove a misleading name for it. As this civilisation flourished at about the period of transition from the Stone to the Metal Age it gives us a glimpse of life at a time long after that of Palæolithic Man, whose remains are so particularly abundant round about Madras, but probably long before that of the pottery sarcophagus and urn burials found within the city of Madras, as well as in the Coimbatore District and elsewhere, though at present best known from Rea's excavations at Adichanallur and Perumbair. For urn burials seem still to have been customary in the days of early Tamil literature. How much earlier than that they came into use it is as yet impossible to say. Nor do we seem to have any better knowledge regarding the various types of megalithic and cave burials, of which treasure-hunters and cultivators are all too rapidly reducing the greatly diminished number that still remain with their contents intact.

The excavation of Taxila,[5] commenced by General Cunningham in 1863, and continued on modern lines and with much greater thoroughness and understanding than was then possible by Sir John Marshall from about 1912 onwards, has unearthed a sequence of three lost cities of great early renown, of which the first seems already to have flourished in far off mythological times, having been conquered, according to the Mahabharata, by King Janamejaya of snake sacrifice fame. In historical times it would be this city that offered hospitality to Alexander the Great, and in which Asoka ruled for a time as his father's viceroy. On the decline of the Maurian Empire, however, it was captured by Greeks from Bacteria, who shifted their capital to the second city early in the second century B.C. This second city remained the capital, passing under the sway first of the Sakas or Scythians and later of the Parthians, till it was sacked by the Kushans (probably shortly before 64 A.D.) who then founded the third city, which in its turn was laid waste during the fifth century A.D., presumably by the White Huns who conquered the Kushans and ultimately also the Guptas. Taxila thus carries us far on into historical times, and illustrates the many changes and vicissitudes that beset the capital of a frontier state in those early days.

The great majority, as well as the finest, surviving monuments of the early part of Indian historical times are Buddhist. Before the discovery of Mohenjo-daro and Harappa, these were generally regarded as being the oldest surviving Indian monuments of any importance and, both on account of their antiquity and of the marvellous sculpture which many of them showed they have attracted more attention than any other class of Indian monument. One has, indeed, only to mention places such as Sanchi, Buddh Gaya, Larnath, Bharhut, Pataliputra, Nalanda, Ajanta, Karli, Amaravati, Nagarjunakonda and a host of others to realise what a wealth of excavation, description and illustration has been bestowed upon them. But even among Buddhist remains new discoveries continue to be made, as well as among the more scanty Jain remains, many of which belong to about the same period.

Hindu remains are, generally speaking, less ancient than Buddhist, yet much less seems to be known about them. The Archæological Survey and other bodies have, it is true, published finely illustrated monographs on various important temples and

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[2] "The Racial Affinities of the Peoples of India," by B. S. Guha, in "Census of India, 1931, I (3), Ethnographical" edited by G. H. Hutton (Govt. of India Press, Simla, 1935).

[3] "The Position of Mysore in India's Racial History" by Baron von Eickstedt in Vol. I of Ananthakrishna Aiyar's "Mysore Tribes and Castes" (Mysore University, 1935).

[4] "Explorations in Sind" by N. C. Majumdar (Delhi, 1934); "The Indus Valley Civilisation" by E. J. H. Mackay (London, 1935).

[5] See "A Guide to Taxila" by Sir John Marshall (Calcutta, 1918).

groups of temples, such as those of the Deccan,[6] and of the Chalukyan country,[7] or of the Hoysala Dynasty[8] of Mysore or the Pallava Dynasty[9] of the Tamil country, as well as on many lesser groups; but only one serious attempt seems yet to have been made to apply scientific methods of treatment to the development of plan, ornament, etc., that took place in all styles of architecture as time went on, and to use the information thus obtained in the reconstruction of the history of the monuments. This attempt was successfully made by Prof. Jouveau-Dubreuil of Pondicherry, now over twenty years ago, but was concerned only with the kind of temple characteristic of the Tamil country.[10]

The earliest surviving typical specimens of this kind of temple are small monolithic examples which, as was pointed out by Fergusson long ago in his *History of Indian and Eastern Architecture*, show unmistakable evidence in their general structure of the influence of earlier many-storied Buddhist monasteries, such as the celebrated "Brazen Palace" at Anuradhapura in Ceylon, the stone columns of the ground floor of which are still standing, arranged as in a typical early South Indian *mandapa* or pillared hall. Apart from this the ornamentation of these early Tamilian temples is extremely simple, and forms the commencement of a series of steadily increasing elaboration, apparently undisturbed or practically so by any outside influences, which can be traced through the remaining 250 years of Pallava supremacy in the Tamil country, the 500 years of Chola supremacy and the 250 years of Vijayanagara supremacy (during which 250 years this kind of architecture spread all over South India), to a modern period which began in about 1600 A.D.

Thanks to this work it is now possible for a person with a little simple and elementary archæological knowledge, such as anyone of normal intelligence can easily understand and remember, to see for himself when visiting a Tamilian temple at what historical period it is likely to have been built, whether earlier buildings have been incorporated into its structure, and whether alterations or additions of later date have been made; a check has become available by which to test whether buildings recorded in literary records are original or are reconstructions of a later date; and a scientific basis has been provided for the dating of temples for which no literary evidence of the date of construction is available.

Outside the Tamil country such information is equally badly needed but has not yet been provided. In certain districts it might be expected that temples as early as the earliest surviving Tamilian ones might have been strongly influenced by the wealth of decoration lavished on neighbouring cave temples. But Cousens[11] says:—"As the Dakkan temples are found spread over that part of the country in which the bulk of the older cave-temples occurs it would be natural to expect to see some analogy between the architectural details of both, but it is surprising to see how little there is. A greater likeness is found between cave work and that of the seventh and eighth century temples of the early Chalukyas." He specifies, however, certain similarities that do exist and also distinguishes between several northern styles as illustrated by their towers. But, as he does not sufficiently differentiate characteristics connected with locality from those connected with the passage of time, he fails to follow up the clues he has thus provided. From a study of Cousens' monograph on Chalukyan architecture Gravely and Ramachandran[12] have been led to conclude that further field studies would be likely to reveal as definite an evolutionary sequence of ornament in Chalukyan temples and their Hoysala derivatives as Jouveau-Dubreiul has demonstrated in the temples of the Tamil country, but this too remains a mere clue at present.

To sum up—Of prehistoric remains we have descriptions but no understanding; and though there seems to be hope that

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[6] "Mediæval Temples of the Dakkan" by H. Cousens (Calcutta, 1931).

[7] "Chalukyan Architecture, including examples from the Bellary District, Madras Presidency" by A. Rea (Madras Govt. Press, 1896); and "Chalukyan Architecture of the Kanarese Districts" by H. Cousens (Calcutta, 1926).

[8] "Architecture and Sculpture in Mysore" by R. Narasimhachar, several volumes, each devoted to one temple (Mysore Archæological Series).

[9] "Pallava Architecture" by A. Rea (Govt. Press, Madras, 1909); "Pallava Architecture" by A. H. Longhurst (Pt. I, Simla, 1924; Pt. II, Calcutta, 1928; Pt. III, Calcutta, 1930).

[10] "Archéologie du Sud de l'Inde" (Musée Guimet, Paris, 1914); and "Dravidian Architecture" (a brief summary only; S.P.C.K. Press, Madras, 1917).

[11] "Mediæval Temples of the Dakkan", pp. 5–12.

[12] *Bull. Madras Govt. Mus.*, III (1, 1934), pp. 14–20, pl. ii.

current work will now very soon result in some degree of understanding of the cultural status of Palæolithic Man in India, the various types of pre-historic Iron Age burials remain as unintelligible as ever, while the daily press bears constant witness to the rate at which these monuments are being rifled. At Mohenjodaro, Harappa and elsewhere the remains of a forgotten civilisation have recently been brought to light; but this civilisation is still very imperfectly understood and excavation by agencies from within the country have practically ceased. For the period of great Buddhist monuments more work has been done than for any other, but a detailed scientific and comparative study of the evolution of these monuments in the country as a whole is greatly needed, and further exploration and excavation still remains to be done. Among Hindu monuments those of the Tamil country are now fairly well understood, though much work there also is still needed in certain directions; but elsewhere no more than the fringe of the subject has yet been touched. Muslim antiquities form a distinct class by themselves and have not been considered above; but among them too it is clear that much further work is required. How are the needs thus briefly indicated being met?

The Archæological Survey of India, and the departments in the Indian States corresponding to it, are naturally the organisations to which one first turns in trying to answer this question. Some of the major results of their excavations have already been mentioned, and to attempt any more exhaustive summary here is neither possible nor necessary. Really their greatest achievement, however, has probably been the much less spectacular one of helping to make possible, through the agency of the Universities and other educational institutions, an ever deepening appreciation of the cultural value of ancient monuments among the better educated members of the population of the country. What has been accomplished in this direction can best be appreciated by reading the address on "The Ancient Monuments of India" delivered by Lord Curzon before the Asiatic Society of Bengal on February 7, 1900.[13] The "gloomy or regrettable features of the picture" there set forth, including as they do the spoliation by picnic parties armed with hammer and chisel of no less a building than the Taj and the narrow escape of this masterpiece on one occasion from complete destruction for the value of its marbles, sound incredible to-day—though the effects of civil war on the antiquities of Spain ought to counteract any easy complacency we may be tempted to feel as to the future.

Like most other departments, however, the Archæological Survey has a severely limited staff. It has never had and can probably never hope to have, in its regular employ, the large number of well concerned men that would be necessary to ensure the proper conservation of the innumerable ancient monuments of this immense country. Much of the execution of any conservation decided upon has to be left to the supervision of some P. W. D. subordinate—probably himself working under pressure of new constructive work or of repairs to inhabited buildings —and so we get the beauty of ancient buildings marred by conspicuous smears of blatantly modern cement, as happened last year on a particularly picturesque and much visited site; or the ends of each uneven line of an Asokan rock edict erased so that they might be readily fitted to the shelter that had been decided on for their protection, a catastrophe that Dr. Spooner arrived only just in time to prevent at Dhauli in Orissa. The line that has been chiselled through the ends of the lines from top to bottom of the rock records the vandalism that so nearly occurred, and will do so for all time. Nor can conservation rightly be the only concern of this department. Investigation is equally important, for without it the monuments conserved cannot be understood. And as in a college or university research is essential to the maintenance of vitality in teaching, and teaching essential to the expression and diffusion of the results of research, so in an archæological department research is essential to the maintenance of vitality in matters of conservation, and conservation essential to a proper attitude towards research. There are, moreover, innumerable ancient sites which, though not requiring conservation by means of any constructional work, are nevertheless in constant danger of destruction by cultivators or treasure hunters—far more of them than any Archæological Survey can ever hope to get protected by sufficient men of adequate integrity and understanding, till such time as they can be scientifically investigated.

We would therefore appeal to all our readers, and to the educated public generally,

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[13] *Proc. Asiatic Soc. Bengal*, 1900, pp. 56–65.

to take a keen personal interest in locating and watching over such sites and monuments wherever they may be found, promptly reporting to the concerned survey or state department their location, and any special danger to them which may arise, and seeking the immediate aid of the local Government authorities in any case of urgency.

We would also invite the attention of Government to the severe financial limitations under which the Archæological Survey is at present working. In the introduction to an authoritative review of its work during 1933–34 we read "The era of all-round retrenchment and general economising which the Government of India were forced to inaugurate since the financial stress of the year 1931, continued to be felt very seriously in the Archæological Department. Few branches, indeed, of the many-sided activities of the Government have suffered more from reductions in grants than the Archæological Survey. During the year 1933–34 hardly any excavation was possible, and the amounts allotted for conservation work were, on the whole, about one-fifth of what they had been before 1931." How, we would ask, can the country hope to have properly preserved or studied the priceless monuments that survive as indications of the glories of its past history when its Central Government treats in such fashion the department it has created for this purpose? And what effect is such treatment likely to have as an example to the various Indian States on which rest the responsibility for many other such monuments, some of them of exceptional beauty and importance?

Lastly we would call attention to one specially disastrous effect that is bound to result from the stoppage of excavation work by the Survey, namely, the disappearance of the means of training further excavators. The Survey has in the past had in its service a band of unsurpassed excavators mostly European and mostly already retired. How can they be replaced except again from abroad when such excavation as is carried out is done not by the Survey but by foreign investigators? Yet without excavation research is bound to languish. And without vigorous research the Survey cannot hope to retain the vitality essential to its efficiency.

Diamagnetism and Particle Size.

By Prof. H. Lessheim.

THE investigation of the diamagnetic susceptibilities of small particles obtained by colloidalisation or cold-working has shown that apparently a dependence on the size of the particles prevails. S. R. Rao[1] has advanced the opinion that this is due to the immediate influence of the surface, the area of which increases with decreasing particle size, whereas Bhatnagar[2] and collaborators[3] uphold that the increased surface has no immediate reaction on the diamagnetism; it may come in only in so far as it facilitates hydration, oxidation, carbonisation, etc., which processes on their part falsify the measurements. From this point of view the decrease of the diamagnetism is solely an impurity effect, but no inherent property of the material under consideration. Furthermore, Bhatnagar has emphasised the point that colloidalisation may result in producing an allotropic modification with different crystal structure, which will naturally exhibit a different susceptibility, while cold-working may bring about a severe distortion or even a destruction of the crystal lattice with simialr effects on the diamagnetism.

It is the intention of this report to give a critical survey of the whole subject. If, at present, any conclusions can be drawn, they will be that

(1) the theoretical considerations put forward by S. R. Rao do not support his view;

(2) the immediate effect of an increased surface is by far too small to account for the decreased diamagnetism;

(3) the experimental evidence available is in complete agreement with Bhatnagar's view and excludes S. R. Rao's explanation.

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[1] S. R. Rao, *Ind. Jour. Phys.*, 1931, **6**, 241; 1932, **7**, 35; *Phys. Rev.*, 1933, **44**, 850; *Proc. Ind. Acad. Sci.*, 1934, **1**, 123; 1935, **2**, 249; *Curr. Sci.*, 1936, **4**, 572.

[2] S. S. Bhatnagar, *Jour. Ind. Chem. Soc.*, 1930, **7**, 957; *Curr. Sci.*, 1936. **4**, 570.

[3] *Cf.* references 6, 7, 10, 12, 13, 14, 16.

A. The Size of the Particles.

I.

In order to support his opinion that the susceptibility depends directly on the size of the particle, Rao has introduced a classification of the linkages obtaining in metals, in three different types of bonds, which he terms "homopolar", "metallic" and "Ehrenfest-Raman" linkages. The habit of introducing a classification of one's own, and using terms in a meaning different from that for which they are coined, should not be encouraged, particularly after wave-mechanics has been able to give a complete account of the different types of linkages in crystal lattices. Special mention may here be made of Hund's classical paper[4] on the subject.

There is only one way in which a crystal can be built up so as to exhibit metallic properties. This is the case when the number of electrons available (Rao's "extra-ionic" electrons) differs from the number of wave-functions at their disposal, so that a certain state is occupied by only half the number of electrons to be accommodated in it. Then the ground state of the crystal belongs to a continuum of states and any amount of energy, however small, suffices to make these electrons change their positions.

A homopolar linkage of the electrons obtains always when—and only when—their number is identical with the number of states. In this case the ground state is single and has a finite distance from the next continuum; the crystal is an insulator. What Rao calls "Ehrenfest-Raman" binding is not a separate type of linkage at all, but in wave-mechanics a condition satisfied in a number of cases of homopolar linkage, *e.g.*, always in crystal lattices; the term now in general use for it is "non-localisation" of the bonds.

For further particulars Hund's paper[4] may be consulted; it may be mentioned only that transition cases are possible—that of selenium is one of them—especially when layer or fibre lattices are concerned, but the fundamental principles stated above hold always good. So it can easily be seen that Rao's remarks[5] "Bismuth is not a metal in the true sense of the term" and "Graphite is not a metal" are entirely devious. Bismuth and graphite are transition cases on account of their layer lattices; since their ground-states belong to a continuum owing to the splitting of the atomic ground levels on formation of the crystal, they are true metals in the crystallographic sense of the word.

From this it will be seen that Rao's considerations are based on a misconception of the binding conditions in a lattice. Nor has his quoting of Pauli's formula for the paramagnetic susceptibility any definite bearing on the matter under discussion.

II.

We proceed now to consider the influence which an increase of the surface of small crystalline particles can have on physical properties inherent in the crystal structure, *e.g.*, diamagnetism.

A graphite particle of a diameter of $1 \cdot 5\ \mu$ contains about $1 \cdot 5 \times 10^{11}$ atoms. The nearest distance which carbon atoms can have in the graphite lattice is $1 \cdot 5 \times 10^{-8}$ cm. Assuming this to be valid on the whole of the surface, assuming further that on the surface the atoms are packed as tightly as possible, the number of atoms on it will be approximately $3 \cdot 6 \times 10^{8}$. Assuming also that on the surface the diamagnetism breaks down completely, the action of the surface will be about $0 \cdot 0024$ of the total effect. All the assumptions made tend to increase the surface effect. In fact we have nowhere the tightest possible packing, only in very few places of the surface the smallest possible distance, and besides, due to the inter-atomic bonding forces partly breaking down on the surface, the distances of the atoms are considerably larger than in the interior of the crystal; so the figure $0 \cdot 0024$ derived at is essentially too large and therefore does not actually represent the reduction of the diamagnetism to be expected, but an upper limit for it. On decreasing the size of the particle to $0 \cdot 15\ \mu$ the surface effect multiplies by ten, but according to the above, remains still smaller than $2 \cdot 4\%$.

Materially the same holds good in the case of bismuth. Since here the experimental evidence refers to particles of a somewhat larger size, the possible effect of a surface is still less. It is less than $2 \cdot 5 \times 10^{-4}$ for particles of 10μ diameter; and for particles of a smaller diameter the values are found in column 5 of Table I, which is

und, *Zs. f. Phys.*, 1932, **74**, 1, in abbreviated n *Internat. Conf. on Physics*, 1934 (*Phys. Soc.* , 36.

Ind. Acad. Sci., 1935, **2**, 249.

TABLE I.

Bismuth.

1 Diameter of particle	2 $-\chi \times 10^6$	3 $-\chi \times 10^6$ after removing oxides	4 Relative decrease of $-\chi \times 10^6$	5 Relative surface effect	6 Part of the metal found oxidised
Macro-crystal	1·08	1·12	0·036	0·0000	
10μ	0·934	1·13	0·166	0·00025	0·05
2μ	0·741	1·14	0·338	0·00125	0·18
$1·5\mu$	0·588	1·02	0·475	0·0017	0·30
1μ	0·574	1·05	0·487	0·0025	0·31

compiled from the measurements of Mathur and Verma.[6]

From Table I it is obvious that the decrease of the diamagnetic susceptibility (column 4) is not due to any surface effect of the type invoked by Rao. On the other hand, a comparison between columns 4 and 6 shows that the amount of metal found oxidised is of the same order of magnitude as the decrease of $-\chi$. A complete agreement between the figures of those columns cannot be expected, because several oxides of Bi are formed; the proportions of these oxides vary and need not be equal in different samples. The fact, however, that the figures of column 4 are slightly higher than those of column 6, manifests the influence of paramagnetic oxides of bismuth.

The case of antimony is equally lucid. In full it is discussed later, but in Table III, referring to it, that fraction of the decrease in diamagnetism, which may be accounted for by an increasing surface, is also given and shows again, that it is of an inferior order of magnitude.

Similar experiments on lead have been performed by Verma and Haque,[7] which will be fully discussed later. In this place we have to mention only, that when lead powders of sizes between 0·4 and 0·6μ were melted in a vacuum tube the susceptibility remained absolutely constant, whether or not the oxide was removed before enclosing the powder in the tube. This is again conclusive evidence that within the error of the experiment the susceptibility does not depend on the size of the particles, provided the crystal structure is unchanged. Also spongy lead obtained by electrolysing a solution of caustic soda with lead electrodes and lead powders chemically precipitated in different sizes by displacing lead from its salts by magnesium, aluminium or cadmium showed precisely the same susceptibility ($-1·22 \times 10^{-7}$) as mechanically powdered lead and the mass metal.

III.

From the above considerations it can be seen that it is certainly not the size of the particle that is responsible for the decrease of the diamagnetic susceptibility. This is corroborated by an interesting piece of evidence. G. R. Levi[8] and later W. Zachariasen[9] have shown that the red and the yellow mercury oxides are structurally identical and that the difference in colour is due to a difference in paritcle size only. If the particle size was in any way decisive of the magnetic properties of a substance the red and yellow oxides should display different susceptibilities, which they however, do not. Mathur and Nevgi[10] have shown that the susceptibility of the red variety is identical with that of the yellow one ($-0·24 \times 10^{-6}$).

Another similar example is furnished by the experiments on lead by Verma and Haque[7] already quoted above. Lead crystals obtained under different conditions appear in two distinct varieties, *i.e.*, in the so-called "leafy" form and in the "dark regular" form. They are, however, identical from the crystallographic point of view

[6] R. N. Mathur and M. R. Verma, *Ind. Jour. Phys.*, 1931, **6**, 181.

[7] M. R. Verma and M. A. Haque, *Proc. Ind. Acad. Sci.*, in press.

[8] G. R. Levi, *Gazz. Chim. Ital.*, 1924, **54**, 709; 1928, **58**, 417.

[9] W. Zachariasen, *Zs. f. Phys. Chemie.*, 1927, **128**, 421.

[10] R. N. Mathur and M. B. Nevgi, *Zs. f. Phys.*, in press.

and they show also the same diamagnetic susceptibility of $-1 \cdot 22 \times 10^{-7}$.

B. THE INFLUENCE OF OXIDATION.

In most of the cases of apparently decreasing susceptibility it has been proved that the foreign influence which falsifies the measurements is that of a surface coating of oxides and sub-oxides. It is obvious that the proportionately very large surface area of a fine powder is predisposed to all sorts of contamination, so much so that even platinum particles proved to be covered by layers of oxides and oxy-acids.[11]

It is quite clear that a contamination of the particles owing to oxidation is not a mere surface effect which affects only a monomolecular layer of the surface, but that it penetrates deeply into the interior of the particle, often causing an oxide layer of more than $0 \cdot 1\mu$ thickness. Thus not only the surface, but a considerable part of the particle is affected, in the case of antimony (*cf.* Section V) upto as much as 47 % of the total mass, causing an effect of an order of magnitude quite different from that of a mere surface influence. If the ratio of the thickness of an oxide layer to the total diameter of the particle is denoted by χ, the influence of such a layer is given by

$$I = 6\chi - 12\chi^2 + 8\chi^3$$

and with diminishing particle size one obtains

χ	I
0·01	0·059
0·05	0·271
0·10	0·488
0·25	0·875

Furthermore, the oxides formed are often paramagnetic, which brings about a still stronger decrease of the diamagnetism or even a reversion to paramagnetism (*cf.* Section VI) in definite contradistinction to an influence of a mere surface, on which at the utmost the diamagnetism may break down to zero, but cannot invert its sign.

IV. BISMUTH.

The diamagnetic susceptibility of bismuth has been measured by numerous investigators, lately in particular by Mathur and Verma.[6] The results are given in Table I. They show that, although there is an apparent decrease with decreasing particle size, the original value is completely recovered, when the oxides are washed off with tartaric acid. It can also be seen that the bismuth removed in the form of oxides amounts to quite a considerable quantity. In order to confirm these results another series of experiments was undertaken,[12] the powdering being done under liquid paraffin and benzene to prevent oxidation as far as possible. The results are tabulated in Table II, showing that now the decrease is much

TABLE II.

Bismuth.

Diameter of particle	$-\chi \times 10^6$ before removing the oxide	$-\chi \times 10^6$ after removing the oxide
Macrocrystal	1·27	1·27
1 μ	0·84	1·27
0·7 μ	0·72	1.23

less rapid than before owing to the diminished quantity of oxides formed; on removing also these remnants the original value is entirely recovered, thus proving the susceptibility of bismuth to be independent of the particle size and the apparent dependence to be merely an impurity effect.

Some more experiments on bismuth will be discussed in Parts C and D.

V. ANTIMONY.

Experiments on antimony have proceeded mainly on the same lines as those on bismuth. The results of Verma and Mathur which appear to be the most conclusive ones in this connection, are given in Table III. The influence of the surface itself has been added in column 4 of that table; although it is here much greater than in the case of bismuth or graphite and certainly above the possible error of the experiment, it is by far too small to account for the rapid decrease of the susceptibility. On the other hand, it is quite clear that decrease is due to oxidation, because the value recovers on removing the oxides with the help of hydrochloric acid. This is particularly striking, when the figures of columns 4 and 5 are added (column 6); the surface effect is actually present, but accounts only for a negligible fraction of the total decrease of diamagnetism, the bulk of which is merely an impurity effect. The last two columns have been calculated on the assumption

[11] S. W. Pennycuick, *Jour. Amer. Chem. Soc.*, 1930, **52**, 4621.

[12] M. R. Verma and R. N. Mathur, *Jour. Ind. Chem. Soc.*, 1933, **10**, 321.

TABLE III.

Antimony.

1	2	3	4	5	6	7	8	9
Diameter of particle	$-\chi \times 10^6$ before removing the oxide	Relative decrease of $-\chi \times 10^6$ against 0·841	Relative surface effect	$-\chi \times 10^6$ after removing the oxide	Sum of the figs. in columns 4 and 5	Quantity of oxygen found	Quantity of Sb oxidised, if in the form of Sb_2O_3	Relative decrease due to Sb_2O_3
Macrocrystal	0·812	0·02		0·841	0·841			
5 μ	0·568	0·32	0·005	0·834	0·839	0·052	0·264	0·469
2·5 μ	0·516	0·38	0·010	0·823	0·833	0·080	0·406	0·260
1·5 μ	0·499	0·40	0·017	0·810	0·827	0·090	0·456	0·292
1 μ	0·498	0·40	0·025	0·805	0·830	0·092	0·467	0·299

that the total amount of oxygen found in the sample existed in the form of Sb_2O_3. Of course, it is not to be expected that this comes anywhere even near the truth; most probably quite a number of various oxides are present, but antimony trioxide is the most frequent one among them, and on making the above assumption we should get at least the required order of magnitude of the effect. The last column shows that this is the case indeed; that the figures are in general lower than those in column 3, points towards the presence of some paramagnetic oxide.

Also this is conclusive evidence that the view put forward by Bhatnagar is correct. It is further corroborated by new experiments of Verma and Haque.[7] Pure antimony, the susceptibility of which was measured and found to be $-0{\cdot}80 \times 10^{-6}$, was powdered and particles of sizes 0·4 to 0·6μ graded out. These particles showed at first a decrease of the susceptibility to $-0{\cdot}53 \times 10^{-6}$. Part of this sample was then subjected to hydrochloric acid treatment and sealed in a vacuum tube. The torsion on the magnetic balance was measured before and after melting the sample in the tube and was unchanged in every series of experiments, showing that the particle size did not affect the susceptibility. Another part of the sample was sealed in a vacuum tube without the oxides being removed. After heating to 600° C. and cooling down, the torsion decreased by no less than 11° which means that an oxide had decomposed and a paramagnetic oxide had been formed. This decrease of the torsion remained after melting; but, when the sample was boiled in diluted hydrochloric acid solution and the oxides thus removed, the original value of the susceptibility was regained.

VI. LEAD.

Recent work* on the diamagnetic susceptibility of lead done by Verma and Haque has led to the same conclusions. Lead was carefully and very finely powdered, one part in air, another part under carbon tetrachloride for a very long time (about six weeks for 5 or 6 hours per day). The susceptibility of the sample powdered in air was $+1{\cdot}42 \times 10^{-7}$ owing to the presence of paramagnetic oxides. After washing the powders in hydrochloric acid, they became diamagnetic with a value of $\chi = -1{\cdot}22 \times 10^{-7}$ equal to that of the mass metal. The same was the case with the sample which was powdered under carbon tetrachloride. Its susceptibility was at first $\chi = +0{\cdot}81 \times 10^{-7}$, but recovered to $-1{\cdot}22 \times 10^{-7}$ after hydrochloric acid treatment. Melting the powders in vacuum did not result in any change of the susceptibility. The amount of oxygen in the samples powdered under carbon tetrachloride was found to be no less than 1·52%.

VII. COPPER.

Apart from earlier work, from which safe conclusions cannot be drawn any more at present, copper in colloidal state was examined by Rao[5] and by Verma and Haque.[7] Rao's experiments will be discussed below (Section IX). Verma and Haque's results are as follows:—

* I am indebted to Messrs. M. R. Verma and M. A. Haque for giving me their results before publication.

Chemically precipitated Cu powder .. $\chi = -0.082 \times 10^{-6}$ (χ-value identical with that of the mass metal).

Electrolytically deposited Cu powder .. $\chi = -0.082 \times 10^{-6}$

Particles of 0.4μ diameter graded out by shaking the ungraded powder in benzene .. $\chi = -0.082 \times 10^{-6}$

Particles of $0.2\,\mu$ diameter obtained by about 30 hours grinding under organic liquids .. $\chi = -0.082 \times 10^{-6}$

The same particles of $0.2\,\mu$ diameter after HCl treatment .. $\chi = -0.082 \times 10^{-6}$

This is again clear evidence that the susceptibility does not depend on the particle size; the lower value for the particles after grinding is an impurity effect due to oxidation which disappears when the oxide is removed by washing the particles in hydrochloric acid solution.

VIII. OTHER SUBSTANCES.

Sulphur in the colloidal state was investigated by Gupta.[13] Particles of monoclinic sulphur of sizes $0.4\,\mu$, $0.6\,\mu$, $0.8\,\mu$, $1.0\,\mu$ diameter displayed no deviation whatever from the susceptibility of the mass metal $\chi = -4.71 \times 10^{-7}$.

Tellurium, both crystalline and amorphous, was the subject of an investigation by G. Singh[14]; after powdering up to 50 hours the various particle sizes of amorphous tellurium ranging between diameters of 1.0μ and 0.4μ showed no deviation from the mass value $\chi = -0.31 \times 10^{-6}$ both before and after washing with hydrochloric acid. The crystalline variety displayed an apparent decrease of $-\chi \times 10^6$ with decreasing particle size, but an exactly parallel decrease of the density of the samples indicated the presence of impurities. After hydrochloric acid treatment the mass values of the susceptibility as well as of the density were completely recovered.

Selenium was examined by Dharmatti[15] who found that on powdering, the diamagnetic susceptibility apparently decreased and eventually changed to paramagnetism. Verma and Gupta[13,16] repeated these experiments on the red and grey varieties of amorphous selenium, the samples being subjected to prolonged powdering under benzene or toluene to prevent oxidation as far as possible. The results are tabulated in the following Table; in each case the value for the mass metal was completely recovered after washing the samples in hydrochloric acid solution.

TABLE IV.

Amorphous Selenium.

(*a*) Grey variety.

Size of particles	$-\chi \times 10^7$ before removing the oxides	$-\chi \times 10^7$ after removing the oxides
Mass metal	3·01	3·06
$1.0\,\mu$	2·89	3·05
$0.7\,\mu$	2·73	3·01
$0.55\,\mu$	2·69	3·01
$0.35\,\mu$	2·69	3·01

(*b*) Red variety.

Size of particles	$-\chi \times 10^7$ before removing the oxides	$-\chi \times 10^7$ after removing the oxides
Mass metal	3·03	3·03
$0.6\,\mu$	3·01	3·01
$0.35\,\mu$	2·61	3·00

Also these results are conclusive evidence that the decrease of diamagnetism, originally attributed to an influence of the particle size, is an impurity effect owing to a contamination of particles by oxides. In this connection Kohlschütter's experiments on silver sols[17] should be mentioned, only in order to show, how far the presence of a very little quantity of oxidised matter can go in shamming a physical phenomenon. These sols differ in colour according to the glass vessels in which they are prepared; they are from reddish-violet to dark blue in Jena glass and from yellow-brown to rose-red in ordinary soft glass. This variation in colour was neither due to particle size nor to contamination by substances originating from the

a, M.Sc., *Thesis*, Lahore, 1935.

.Sc., *Thesis*, Lahore, 1935.

atti, *Nature*, 1934, **134**, 497.

[16] M. R. Verma and I. C. Gupta, *Curr. Sci.*, 1935, **3**, 611.

[17] V. Kohlschütter, *Zs. f. Electrochemie*, 1908, **14**, 94.

material of the glass vessel, but solely due to a different content of Ag_2O determined by the adsorption relationship of the walls.

C. INFLUENCE OF SURFACE COATINGS OTHER THAN OXIDES.

IX. CARBONISATION.

As far back as 1837 it was known[18] that carbon or at least carbonised matter will deposit on colloidal particles of bismuth when the powdering is done under water in such a manner that normal air containing carbon dioxide has access to them. This is precisely what Rao[19] has done in his experiments, and the decrease of the diamagnetic susceptibility found by him after carefully removing the oxides can only be due to carbonisation, other sources of facial impurities having been eliminated.

Colloidal particles of copper were prepared by Rao[5] by means of sparking under benzene and propyl alcohol. In this procedure huge quantities of carbon are deposited on the particles, often even as much as to be visible to the unarmed eye, and propyl alcohol is particularly bad in this respect. Since Rao has had no opportunity of decarbonising his samples, the result was the strange effect of increasing diamagnetism with decreasing particle size, brought about by the carbon impurity, the diamagnetic susceptibility of which $(-5\cdot88\times10^{-6})$ is many times higer than that of copper $(-0\cdot082\times10^{-6})$.

In this connection mention may also be made of a paper by Bhatnagar, Mathur and Kapur[20] who investigated the magnetic properties of iron, nickel, cobalt and manganese adsorbed on carbon surfaces and found that due to the adsorption they lose their paramagnetism and become diamagnetic. A similar effect is of course to be expected, when carbon is adsorbed on the surface of colloidal particles of these metals.

X. ADSORPTION AND ABSORPION OF GASES.

It is obvious that also other films of absorbed or adsorbed matter, especially gases, may have the effect of falsifying the magnetic measurements. Simon[21] found that chabasite ($CaAl_2Si_4O_{12}$) when adsorbing argon, showed a sudden break in the magnetic susceptibility on reaching the ratio of one molecule of argon per one molecule of chabasite, accompanied by a similar break of the iso-thermal curve.

D. INFLUENCE OF STRUCTURAL CHANGES.

As far as changes of the susceptibility are due to a change of crystal structure, we have to distinguish between two different possibilities.

If the change of structure is due to distortion, drawing, annealing, etc., without the lattice arrangement being entirely converted, we have to expect a gradual alteration of the magnetic properties as the corresponding stresses increase. Such influences on macrocrystals have been observed by Bitter[22] and by Lowance and Constant[23] who found that as an indicator of stresses the susceptibility is particularly sensitive. A similar influence in the microcrystalline region appears to be responsible for the dependence of the susceptibility of graphite on the size of the particle (Section XIV).

If, however, the crystal changes directly to a different structure, we have to expect an abrupt, not a gradual, change of the susceptibility on transition. Such changes appear to be much more frequent than hitherto assumed. They can simply be due to the pressure exerted on powdering or cold-working, *e.g.*, amorphous selenium changes easily from the red to the grey-black variety,[24] other changes, *e.g.*, on graphite, have been established with the help of X-radiograms[25]; others have been found out occasionally (*cf.* Sections XII, XIII and XIV) and many more, specially when the change is not indicated by a change in colour or other obvious physical properties, may still be unknown. In any case the importance of satisfying oneself, that no change of structure has occurred, before attributing a physical phenomenon to the influence of mere particle size cannot be emphasised enough.

XI. LEAD OXIDE.

The yellow oxide of lead has a susceptibility[10] of $\chi = -0\cdot197\times10^{-6}$, whereas the

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18 P. A. V. Bonsdorff, *Pogg. Ann.*, 305, **41**; 1837, **42**, 325; quoted after Mellor, IX, 626.

19 S. R. Rao, *Ind. Jour. Phys.*, 1931, **6**, 243.

20 S. S. Bhatnagar, K. N. Mathur and P. L. Kapur, *Ind. Jour. Phys.*, 1928, **3**, 53.

21 F. Simon, *Zs. Phys. Chemie.*, 1928, **132**, 456.

22 F. Bitter, *Phys. Rev.*, 1930, **36**, 978.

23 F. E. Lowance and F. W. Constant, *Phys. Rev.*, 1931, **38**, 1547.

24 P. V. Schrott, *Phys. Zs.*, 1907, **8**, 42.

25 G. Asahara, *Scient. Pap. Inst. Phys. and Chem. Res. Tokyo.*, 1922, **1**, 23.

red variety has a value of $\chi = -0{\cdot}211 \times 10^{-6}$. This difference is not due to a different size of the particles, but to a definite change of crystal structure. Kohlschütter and Scherrer[26] have finally established this fact by the X-ray method and confirmed the view of Applebey and Reid,[27] who concluded from crystalline and optical characteristics that the red oxide is uniaxial and rhombic and has a negative optical character, whereas the yellow one is biaxial, rhombic and positive.

XII. Antimony.

Most interesting in this connection is the work of Prins,[28] who has been regrettably misquoted by Rao.[29] The result of Prins's work is not, as alleged by Rao, that the diamagnetic susceptibility of colloidal antimony is smaller than that of the mass metal, but on the contrary, Prins has verified that his "amorphous" antimony is identical with Gore's "explosive" antimony and of a structure different from that of the mass metal; it is therefore definitely not colloidal, *i.e.*, consisting of small particles which are otherwise of the same structure as the mass metal is. Prins has not failed to state expressly that the different value of the diamagnetic susceptibility (not a continuous decrease!) is exclusively due to the altered structure and that this is corroborated by a change in the electron diffraction pattern as well as by the work of Cohen and Strengers,[30] who have directly measured the heat of crystallisation liberated on transition from the amorphous to the crystalline state.

On the other hand, new experiments of Verma and Haque have established the fact that colloidal powder of antimony retains its crystal structure and is not amorphous. Powders of $0{\cdot}4$ to $0{\cdot}6\mu$ diameter were sealed in a vacuum tube and the torsion in the magnetic balance measured. If they were amorphous, they should change into the crystalline variety at about 120°–150° C. and the corresponding change of the magnetic properties should ensue. In fact heating upto 360° C. did not produce any alteration in the torsion, which proves that no change of crystal structure occurred and the samples had remained crystalline when being powdered.

XIII. Bismuth.

Here comes also the evidence which has lately been collected to show a kind of superstructure in the crystal lattice of bismuth. It is clear that, if a macrocrystal consists of microcrystals, particles of sizes corresponding to that of one or more microcrystals should display physical properties different from those in size below that of a microcrystal. A transition between these sizes would then be equivalent to a certain change of structure and on passing that critical size an abrupt change of the susceptibility may ensue.

Goetz and Focke[31] found that in bismuth crystals infected by foreign atoms these foreign atoms tend to arrange themselves on the boundaries of groups of atoms thus producing surface effects on these microcrystals. Focke,[32] infecting bismuth crystals with polonium atoms, which he then observed with the help of a Geiger counter, found that the polonium had come into a regular order, the atoms arranging themselves in planes distant by $0{\cdot}54\mu$ parallel to the (111) plane and $0{\cdot}90\mu$ parallel to the $(11\bar{1})$ plane.

So far magnetic evidence in support of a superstructure in bismuth crystals has not been obtained.

Lane[33] has conducted magnetic experiments on bismuth films of various thicknesses. Although for several reasons[34, 35] his experiments do not prove what they were intended to prove, *i.e.*, that the susceptibility is independent of particle size, which fact has been otherwise established in the meantime (*cf.* Sections II and IV), on checking his results Goetz[34] found that the first few thousand layers of bismuth atoms deposited as film on a plate show rather an amorphous structure entirely different from the ordinary crystal structure assumed by the atoms deposited later. This case seems similar to that of amorphous antimony (Section XII), and a definite change of the magnetic properties is to be expected, if one succeeds

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26 V. Kohlschütter and P. Scherrer, *Helv. Chim. Acta.*, **1924**, **7**, 337.

27 M. P. Applebey and R. D. Reid, *Jour. Chem. Soc.*, **1922**, **121**, 2129.

28 J. A. Prins, *Nature*, 1935, **136**, 299.

29 [illegible] *Curr. Sci.*, 1936, **4**, 573.

[illegible] Th. Strengers, *Zs. Phys. Chem.*,

31 A. Goetz and A. B. Focke, *Phys. Rev.*, 1934, **45**, 170.

32 A. B. Focke, *Phys. Rev.*, **45**, 219; 1934, **45**, 623.

33 C. T. Lane, *Nature*, 1932, **130**, 999.

34 A. Goetz, *Nature*, 1933, **132**, 206.

35 S. R. Rao, *Nature*, 1933, **132**, 207.

in obtaining particles consisting entirely of such amorphous bismuth.

XIV. GRAPHITE.

Similar evidence for the existence of a superstructure as in the case of bismuth exists also in that of graphite. Also here Goetz[36] thinks the existence of groups of atoms in the crystal possible, mainly in consequence of the work of Krishnan and Ganguli,[37] who found that in a graphite crystal, which has a layer lattice, foreign oxygen atoms arrange themselves between the layers, thus affecting the susceptibility perpendicular to the layers, but not that along the basal plane. This evidence, though in complete accord with our view, appears still to require further corroboration, particularly in view of the fact that the earlier experiments on graphite performed by Paramasivan[38], Vaidyanathan[39], Rao[19] and Miwa[40] do not seem to be sufficiently decisive to serve as basis of a theory.

Apart from this the dependence of the diamagnetism of graphite on particle size seems to have quite a natural explanation, which was also first suggested by Krishnan and Ganguli[37]. Graphite (*cf.* the Introduction) with its layer lattice is a transition case of linkage, the metallic bonds occurring only along the c axis, *i.e.*, perpendicular to the basal plane, whereas in the basal plane the linkage is of a homopolar type. This causes a strong anisotropy of the physical properties, particularly of the magnetic susceptibility, the statements in literature[41,42] of the value of χ_1/χ_2 varying from 1/28 to 1/57. It is further known that on decreasing particle size the distance between the successive layers gradually increases[40], which indicates a weakening of the bonds along the c axis and a corresponding perturbation of the crystal structure in this direction. This would easily explain the decrease in diamagnetism with decreasing particle size, and preliminary measurements of Krishan and Ganguli[37] appear to confirm that χ_2 diminishes with decreasing particle size, whereas χ_1 is indepenent of it.

XV. OTHER SUBSTANCES.

Honda and Shimizu[43] found a change of diamagnetism of copper and tin on cold-working. In this case the crystal structure was forcibly changed or at least severely disturbed, which accounts easily for the effect observed. This is supported by experiments of Rao[44], who has shown that the paramagnetism of the white crystalline tin turns gradually into the diamagnetism of the tin atom, as on progressive powdering, the crystal structure is gradually destroyed. It appears also possible that owing to the pressure exerted on powdering the white tin was partly converted into the diamagnetic grey variety.

On the other hand, when the powders or films to be examined are obtained not by grinding, but by chemical precipitation or by electrolytic or mechanical deposition, small sizes of particles or thin layers of films cannot be expected to have the same structure as the mass substances, due to the proper crystal structure being capable of formation only, when a greater number of atoms are present. Lately, for many metals a large amount of evidence has been collected on this point[45], which cannot fail to demand due consideration in the examination of the magnetic properties of colloidal particles.

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36 A. Goetz, *Internat. Conf. on Phys.*, 1934 (*Phys. Soc. Lond.*), **2**, 62.

37 K. S. Krishnan and N. Ganguli, *Curr. Sci.*, 1935, **3**, 472.

38 S. Paramasivan, *Ind. Jour. Phys.*, 1929, **4**, 139.

39 V. I. Vaidynathan, *Nature*, 1929, **124**, 762; 1930, **125**, 672; *Ind. Jour. Phys.*, 1930, **5**, 559.

40 M. Miwa, *Sci. Rep. Tohoku Imp. Univ.*, 1934, **23**, 242.

41 B. C. Guha and B. P. Roy, *Ind. Jour. Phys.*, 1933, **8**, 345; K. S. Krishnan, *Phys. Rev.*, 1934, **45**, 115.

42 A. Goetz, A. B. Focke and A. Faessler, *Phys. Rev.*, 1932, **39**, 169, 553; A. Goetz and A. Faessler, *Phys. Rev.*, 1932, **40**, 1053; A. Goetz, *Phys. Rev.*, 1934, **45**, 282.

43 K. Honda and Y. Shimizu, *Nature*, 1930, **126**, 990; 1935, **135**, 108.

44 S. R. Rao, *Proc. Ind. Acad. Sci.*, 1934, **1**, 123.

45 *Cf.* General Discussion of the Faraday Society on "The Structure of Metallic Coating Films and Surfaces", *Trans. Far. Soc.*, 1935, **31**, 1043–1290; particularly:—G. I. Finch, A. G. Quarrel and H. Wilman, *Trans. Far. Soc.*, 1935, **31**, 1051; E. N. da G. Andrade, *Trans. Far. Soc.*, 1935, **31**, 1137.

On the Physical Properties of Crystals.

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THE most characteristic feature of a crystal is its geometrical form. This is not a matter of mere coincidence but is specific with the nature of the internal bondage between the various units in the lattice. The crystal structure thus corresponds to minimum potential energy[1] and is thermodynamically the most stable one. The energetics of crystals have been studied by Born and others[2] and depend on the nature of crystals having (1) heteropolar or ionic lattice, metallic lattice being a special case with electrons as the negative ions; (2) dipole lattice, *e.g.*, the halogen acids; (3) molecular lattice of neutral atoms, *e.g.*, organic crystals. Of these those of class (1) have been studied in detail and the free energy and equation of state have been derived. Thus at absolute zero

$$E = -\frac{K}{\delta} + Ce^{-\alpha\delta} + \frac{C'}{\delta^6} + \epsilon$$

where δ is the lattice distance, K, C, C′ are constants. The first term is the Coulomb energy, the second a repulsive energy term, the third van der Waal dipole-dipole-polarisation energy term and the last null-point energy. Besides these there may be other terms involving higher inverse powers of δ. The above equation may be used for the calculation of free energy, minimum distance of approach, pressure and cohesive force. Thanks to Sommerfeld, Bloch, Peierl and others,[3] the theory of metals has been well established and it has been possible to account for conductivity and other properties on the concept of free electrons, the motion of which is somewhat restricted by 'interaction terms'. Wave-mechanical method has also been applied to complex crystals by Hund, Mulliken, Pauling and others.[4]

The properties of crystals as predicted by theory are not always borne out by experiment and several anomalies have been observed. In fact Smekal[5] has classified these as structure-sensitive, semi-sensitive and insensitive. The last are in accord with theory and these include density, refractive index, elastic properties, specific heat, conductivity, etc. The first are selective and show wide departure from theory. To these belong plasticity, tensile strength and some anomalous dielectric and magnetic properties. The second is intermediate between the first and the last, for instance, conductivity of non-metallic crystals, diffusion, X-ray extinction, etc. According to Darwin,[6] intensity of X-ray scattering alone may serve to distinguish perfect crystals from imperfect ones. The ideally perfect crystals we have for integrated reflection

$$\rho = \frac{\delta}{3\pi}\,\frac{N\lambda^2}{\sin 2\theta_0}\cdot|F|\cdot\frac{e^2}{mc^2}\cdot\frac{1+\cos|2\theta_0|}{2}\cdot\phi(T)$$

and for ideally imperfect ones

$$\rho = \frac{N^2\lambda^3}{2\mu\sin 2\theta}\left(|F|\frac{e^2}{mc^2}\right)^2\cdot\frac{1+\cos^2 2\theta}{2}\,\phi(T)$$

where

N = Number of crystal units per unit vol.; F = Scattering factor per unit cell; e, m, c have their usual significance; θ = Glancing angle; θ_0 = Bragg angle; λ = Wave-length; μ = Linear absorption coefficient.

Real crystals are usually intermediate between two extreme cases.

The classification due to Smekal is not also rigid. As a general rule structure-sensitive properties tend to become insensitive with rise of temperature, while cold-working has just the opposite effect. Again some apparently sensitive properties become insensitive, for instance, elastic after-effects and dielectric anomaly become structure insensitive in the case of single crystals.[7]

The most marked discrepancy has been observed in the case of plastic deformation, and cohesive strength even for single crystals. It was, however, noted by Joffé[8] that deformation is attended with elongation of Laue spots (asterism) which is attributed to the breaking up of the single crystal into smaller single crystals. It reminds one of the fibrous structure. The destruction limit decreases rapidly with rise of temperature and reaches zero at melting point. The occurrence of lattice curvature may be explicable if we assume with Taylor and Yamaguchi that they have a local character and are due to slip over a limited region.

The discrepancy between the theoretical and observed value of cohesive strength is

still greater. Thus cohesion for rock-salt is only ·4kg/mm.^{2} as compared to the calculated value 300 kg/mm.^{2} Joffé[9] explains this as due to the surface cracks and showed that much better agreement can be obtained if the surface be dissolved out. His observations have been criticised by Polanyi and Ewald.

Structure sensitive properties find no explanation on the theory of ideal solid state. Since ideal crystals are dynamically most stable, real crystals which are imperfect should be pseudo-stable. Pseudo-stable imperfect crystals may occur at ordinary temperature and a sort of secondary structure due to temporary grouping (as in liquids) may also be possible. Low temperature favours the formation of these pseudo-stable configurations which tend to become transformed into the stable ones with rise of temperature. Application of pressure may cause a single crystal to take up a crystallite structure like that of glass. Bridgmann[10] considers that at high pressure lattice itself may be destroyed and the crystal converted into a jelly (which again may be regarded to have a crystallite structure).

Bragg[11] has proposed another ingenious mechanism for the formation of real crystals. The repulsive forces within crystals may be directive and this may lead to asymmetry. With the lowering of temperature the crystal may be subject to strains which may lead to secondary grouping[12] and may also account for the cracks and flaws suggested by Smekal. Other instances of directive forces in molecular physics are not wanting and the above hypothesis may be of interest.

Causes of imperfection in real crystals may thus be reviewed as follows: (1) Mechanical distortion during growth of crystals (flaws, crevices, cracks). (2) Accumulation of stresses detected in metallic crystals. (3) Incorporation of impurities which may be hardly avoided.

The existing theories of real crystals are: (1) Mosaicity due to (i) primary and secondary flaws (Smekal), (ii) surface contraction and secondary structure, (iii) Darwin's theory, (iv) Apparent mosaicity due to lineage structure (Buerger[13]); (2) Griffith's theory of cracks extended by Orawan[14]; (3) Inner adsorption (Balarew[15]). Each of these has its merits and demerits adequately discussed lately. Brief mention of these will now be made.

Smekal considers the ideal lattice as thermodynamically most stable and the flaws and cracks are due to defective growth and presence of impurities. These primary flaws may subsequently give rise to secondary flaws of microscopic dimension either by alteration of temperature or by mechanical effects. Properties of crystals depend on the condition of crystallisation and the anomalies may be readily explained. Structural flaws may actually be detected. The following criticism against Smekal's theory may however be advanced. Variation of density (Goetz), anomalous behaviour in connection with electrical conduction and low tensile strength cannot be quantitatively explained. Dimension and shape of blocks due to flaws are vague.

Zwicky assumes that real crystals are dynamically most stable and Goetz has advanced the following arguments in favour of the group structure: (i) Observation of lines and markings of etch figures, (ii) persistence of paracrystalline structure in liquids a few degrees above the melting point, (iii) difference in behaviour of crystals partly within and partly outside magnetic field, (iv) presence of a critical concentration of impurities, (v) difference in coefficient of expansion measured by optical and X-ray methods, (vi) size effect on certain properties and the existence of critical size. Buerger opines that the above evidences are fallacious and the secondary structure theory is based on misinterpretation of observed facts, all of which can be explained otherwise. The main objection is that theory is based on a erroneous calculation of energy (Orawan), and the ideal lattice is thermodynamically most stable. This is borne out by the fact that mosaicity is not a constitutional property and Ewald and Renniger[16] have been able to prepare ideal crystals of rock-salt which is ordinarily mosaic. Crystallographic considerations are also against the secondary structure hypothesis.

Buerger's theory is based on observational evidences and its origin is not clearly understood. Darwin's theory is also not free from objection. Existence of crystals smaller than the critical size according to Darwin's model and certain difficulties as regards crystal formation may be cited as serious objection against Darwin's theory, which also presumes the crystallite structure for imperfect crystals.

It is interesting to study the effect of impurities on the physical properties. Foreign matters can hardly be avoided during

the growth of crystals and these have been considered responsible for cracks by Smekal and of secondary structure by Goetz. The impurities may either form solid solutions and may go the same space lattice as the mother atoms (Ag in Cu) may give rise to super-lattice as in alloys, form layers or lacunes in crystals or accumulate at the boundary of groups or build up adsorption layers superficially or internally or both. In either case these may disturb lattice, in some cases these may give rise to the formation of minute crystals (as in glass[17]) or distort the crystalline form and change the dimension and form of crystal structure. Their presence may also bring about a re-distribution of energy and hence result in stable forms other than perfect lattice. Removal or rearrangement of impurities may be effected by heat or other agencies and thus lead to a more perfect structure. Cold-working may have the reverse effect. Special care taken to exclude impurities may yield ideal crystals. It may be noted that the inequality in thermal expansion measured by optical and X-ray methods disappears if impurities are absent. Details of the effect of adsorbed matter on crystal structure and properties of crystals will be discussed elsewhere.

In conclusion it may be observed that real crystals are usually different from ideal ones which can be obtained only under special circumstances. Absolutely pure crystals should ordinarily have ideal lattice as the most stable, but pseudo-stable imperfect crystals may also occur at ordinary temperature. None of the existing theories are free from defects. A satisfactory theory is however difficult to propound unless the rôle of impurities is properly understood. In fact the study of imperfect crystals reminds one of colloidal substances on the one hand and of liquids on the other.

References.

1 Grüneisen, *Handbuch d. Phys.*, **10** (Second Edition).

2 Born, *Atomic Theory of the Solid State*; Born and Meyer, *Z. f. Phys.*, 1933, **75**, 1.

3 Somerfeld, *Z. f. Phys.*, 1928, **47**, 1; Bloch, *ibid.*, **52**, 555; **59**, 208; Peierl, *Ann. d. Phys.*, **4**, 121; **8**, 244; Hume Rothary, *The Metallic State.*

4 Hund, *Z. f. Phys.*, **73**, 565; Mulliken, *Phys. Rev.*, **41**, 751; **43**, 27; Pauling, *J. Chem. Phys.*, **1**, 562, 606; Hückel, *Z. f. Phys.*, **83**, 632.

5 Smekal, *Handbuch d. Phys.*, **24/2** (Second Edition).

6 Darwin, *Phil. Mag.*, **27**, 675; **43**, 800.

7 Joffé *Physics of Crystals.*

8 Joffé, *loc. cit.*; Komar, *Z. f. Krist.*, **94**, 22.

9 Joffé, *loc. cit.*

10 Bridgmann, *Physics of High Pressure.*

11 Bragg, *The Solid State*, 114. (International Conference).

12 Zwicky, *Rev. Mod. Phys.*, **6**, 193; Goetz, *Phys. Rev.*, **45**, 252.

13 Buerger, *Z. f. Krist.*, **89**, 195.

14 Orawan, *ibid.*

15 Balarew, ref. 13, p. 268.

16 Ewald and Renniger, ref. 11, p. 57; Renniger, ref. 13, p. 344.

17 Randall *et al*, *Z. f. Krist.*, 1930, **75**, 195.

India's Mineral Wealth.*

THE excellent account of India's mineral industry prepared by Dr. Coggin Brown should be in the hands of all those interested in the subject whether they be geologists, mining engineers, mine owners or mineral buyers, or those interested merely in the resources of the country. Dr. Coggin Brown's many years of service in India and Burma, with the Geological Survey, is a guarantee of the reliability of the subject-matter, more especially as he was always concerned more directly with the economic side of Indian geology. He displays here that facile ability with his pen, which is noticeable in his past work, to assemble the principle features of each subject in such a way as to make its reading both interesting and pleasurable.

The four parts of the book deal in succession with the mineral fuels, the metals and their ores, other useful minerals, gems and semi-precious stones. Each mineral is taken in turn, its mode of occurrence described, and an outline of each separate industry given, wherever possible. The whole work is nicely balanced. The only criticism which may be made is that the geological map of Bihar and Orissa might have been brought up-to-date.

There is a liberal supply of graphs and tables to illustrate the production of most of the minerals.

The list of selected papers at the end of the volume should be useful to those interested in any particular subject.

J. A. DUNN.

* *India's Mineral Wealth*, By J. Coggin Brown. Oxford University Press. Pp. 335; Rs. 10. With 6 maps and 8 plates.

LETTERS TO THE EDITOR.

CONTENTS.

A New Technique of Complementary Filters for Photographing the Raman Spectra of Crystal Powders.

THE discovery of Menzies and Bär that crystal powders yield Raman lines even so as large single crystals themselves was a step in advance in the experimental study of the Raman spectra of solids. The chief handicap of this method when using the unfiltered radiations of the mercury arc as the exciting source, is the heavy continuous spectrum which causes rapid fogging of the photographic plate so that, in general, only the more intense lines are distinctly recorded. Attempts have not been wanting to devise a suitable technique to get over this difficulty, and mention may be made in this connection

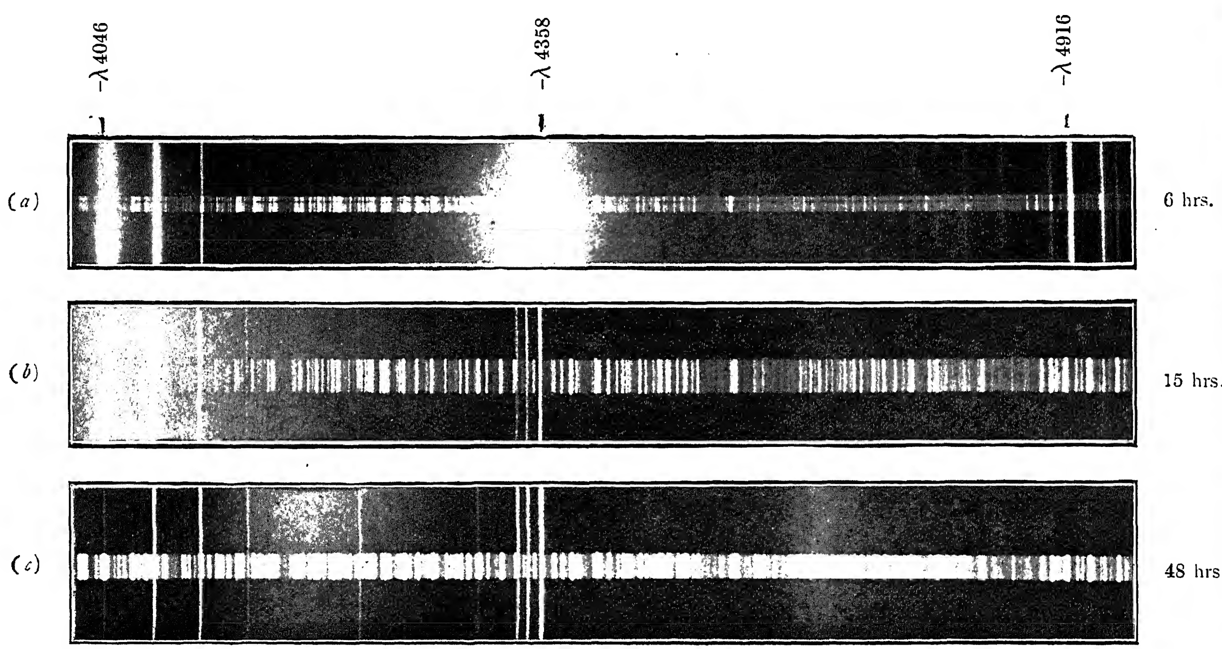


Fig. 1.

to the work of Krishnamurti on the Raman spectra of crystal powders. It is nevertheless true to say that the measure of success achieved has not been very considerable.

Recently, while engaged in the investigation of the Raman spectra of some compounds of the ammonium group, I have found that by a slight modification of the usual powder method, it is possible to record the Raman spectra of solids with as much clarity and completeness as in the case of liquids. In principle, it consists in employing a strictly monochromatic beam for excitation, and absorbing this particular wave-length from the scattered light before the latter enters the spectrograph. Under the circumstances, in the ideal case, only the Raman lines would be recorded on the plate, and if the substance is free from fluorescence, the exposure can be prolonged to any extent to record the complete spectral details.

In practice, these conditions are realised to a fair degree by the use of a concentrated solution of iodine in CCl_4 to filter off the incident radiation of the mercury arc, and a cell of sodium nitrite ($NaNO_2$) solution in front of the slit of the spectrograph. The exciting line in this case is λ 4046 of the mercury arc, and is subsequently absorbed by the solution of $NaNO_2$. The necessity for two such complementary filters will be evident from the photographs reproduced in Fig. 1, which are respectively—

(*a*) the Raman spectrum of $NH_2OH.HCl$ (crystals) using the unfiltered radiations of the mercury arc;

(*b*) the Raman spectrum of $NH_2OH.HCl$ (crystals) using the mercury arc light filtered by a solution of iodine in CCl_4;

(*c*) the Raman spectrum of $NH_2OH.HCl$ (crystals) using the mercury arc light filtered by a solution of iodine in CCl_4, and placing a cell of $NaNO_2$ solution in front of the spectrograph slit.

The duration of exposure in each case is also given against the corresponding picture. The present work clearly shows that the major cause for the fogging of the plate in the usual powder method, is not the continuous spectrum of the mercury arc light itself, but is the general illumination in the interior of the spectrograph when the intense exciting line is allowed inside.

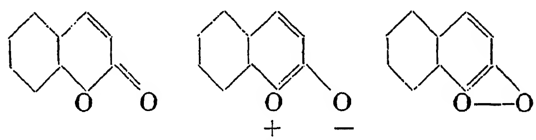
The results of the study of the Raman spectra of some typical solids by the new technique will appear shortly in the *Proceedings of the Indian Academy of Sciences.*

R. ANANTHAKRISHNAN.

Department of Physics,
Indian Institute of Science,
Bangalore,
September 7, 1936.

Structure of Cumarin.

IN the course of a study of the dipole moment of a series of pyrone compounds the moment of cumarin in benzene as solvent and at 20° C. is found to be $4 \cdot 51 \times 10^{-18}$ e.s.u. Although the actual disposition of the moment vector in the molecule has not yet been settled, its value is $0 \cdot 5$ units more than that calculated on the basis of the normal structure for cumarin I. As in the case of γ-pyrone,[1] this increase can be explained as due to an excited state II with which the normal molecule is in resonance.



I II III

The excited phase of the molecule will account for the several addition products of cumarin with metallic salts, the greatly depressed reactivity of the carbonyl group, and also the reduced reactivity of the ethylenic link in the pyrone ring. It can be easily seen that the excited state is but a modern version of the old Clayton[2] formula III, and is in consonance with the Robinson hypothesis of electromeric shift from $\diagup \mathrm{O} \diagdown$ to $\mathrm{C} = \mathrm{O}$ such as occurs in the $-$ COOH group.

Full details will be published in the *Proceedings of the Indian Academy of Sciences.*

M. A. GOVINDA RAU.

Department of Physics,
Indian Institute of Science,
Bangalore,
September 14, 1936.

[1] E. C. E. Hunter and J. R. Partington, *J.C.S.*, 1934, 87. F. Arndt and B. Eistert, *Zeit. Physik. Chem.*, 1935, **31**, 125.

[2] Clayton, *J.C.S.*, 1908, **93**, 524.

Viscosity of Air and Electronic Charge.

THE value of "e", the electronic charge, as found by Millikan in his famous oil-drop method is rather low as compared to that determined by X-ray methods. This value is ascribed to the uncertainty about the value of the viscosity coefficient of air. The value of the viscosity of air as measured by Kellström[1] recently, is higher than that taken by Millikan in his calculations to determine the value of "e". When Kellström's value of η, the viscosity coefficient of air is substituted in Millikan's data, a higher value for "e" is obtained which is nearer to the value of "e" as found by other methods.

We have measured the value of η by a modified form of Wagstaff's method[2] in which air flows through a capillary tube. Our value of η is higher than that used by Millikan and it is interesting to note that our value of η is closer to Kellström's value, who has used the rotating-cylinder method. Thus the two independent methods give values for η which are higher than that used by Millikan.

The value of η (a mean of 61 readings) as found by us is $1855 \cdot 5 \times 10^{-7}$ c.g.s. units at 28° C. This reduces to $1830 \cdot 8 \times 10^{-7}$ c.g.s. units at 23° C. and to $1816 \cdot 2 \times 10^{-7}$ c.g.s. units at 20° C.

The following table gives the values for η at 23° C. as determined by different observers and the corresponding values of "e", the electronic charge, using Millikan's data.

Observer	Method used	$\eta \times 10^{+7}$ c.g.s. units	$e \times 10^{+10}$ e.s. units
Gilchrist[3] (1913)	Rotating-cylinder	1825·7	4·7822
Rapp[4] (1913)	Capillary tube	1822·7	4·7704
Millikan[5] (1913)	Rotating-cylinder	1822·5	4·7704
Harrington[6] (1916)	Rotating-cylinder	1822·6	4·7704
Kellström[7] (1935)	Rotating-cylinder	1834·8	4·8180
Kellström[1] (1936)	Rotating-cylinder	1834·9	4·8180
Authors	Capillary tube	1830·8	4·8022

A detailed report of these experiments will be published shortly elsewhere.

V. D. MAJUMDAR.
M. B. VAJIFDAR.

Physics Department,
Royal Institute of Science,
Bombay, India,
August 29, 1936.

1 Kellström, *Phys. Rev.*, 1936, **50**, 190.
2 Wagstaff, *Phil. Mag.*, 1923, **45**, 84.
3 Gilchrist, *Phys. Rev.*, 1913, **1**, 124.
4 Rapp, *ibid.*, 1913, **2**, 363.
5 Millikan, *ibid.*, 1913, **2**, 109.
6 Harrington, *ibid.*, 1916, **8**, 738.
7 Kellström, *Nature*, 1935, **136**, 682.

Synthesis of 5 : 6-Benzohydrindene.

WITH the expectation of finding out a new method for the synthesis of 1 : 2-*Cyclo*-penteno-Phenanthrene, which is the parent C-skeleton present in the sterols and bile acids, the following preliminary attempt in that direction was made starting from hydrindene. The scheme though failing in the original project is undoubtedly interesting in its application for the synthesis of polycyclic carbon ring compounds.

Succinic anhydride condensed with hydrindene in presence of anhydrous aluminium chloride giving mainly γ-Keto-γ-5-hydrindyl-n-butyric acid (m.p. 123–124°), this on reduction by the Clemmensen method gave γ-5-hydrindyl-n-butyric acid (m.p. 56°) which on cyclisation with 85% sulphuric acid gave 6: 7-Cyclopenteno-1-Keto-1: 2:3:4-tetrahydronaphthalene (b.p. 167°/6 mm.). This Keto compound was reduced by the Clemmensen method to 6 : 7-Cyclopenteno-1 : 2 : 3 : 4-tetrahydronaphthalene (b.p. 125–126°/6 mm.), which on Selenium dehydrogenation at 300–340° yielded 2 : 3-Cyclopentenonaphthalene, *i.e.*, 5 : 6-benzohydrindene, m.p. 94°. Picrate golden yellow needles, m.p. 120–121°. The method is being extended for the synthesis of polycyclic hydrocarbons. The experimental details will be published in a chemical journal in due time.

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Calcutta,
August 21, 1936.

Amino-Acid Dehydrogenases in Germinating Seedlings.

THE importance of asparagine and glutamine in the nitrogen metabolism of the germinating seedling was established by the classical researches of Schulze and confirmed by the later work of Chibnall and others. It is usually assumed that these amides are formed by the combination of the corresponding acids with ammonia arising from the deamination of other amino-acids, though little is known of the mechanism of such deaminisation.

Recent work, notably that of Krebs[1] and Bernheim and Bernheim,[2] has demonstrated the part played by dehydrogenases in oxidative deaminisation in animal tissues; Krebs[3] and Weil-Malherbe[4] have postulated two separate mechanisms involving deaminases which would lead to the formation of glutamine in such tissues, though the presence of the latter in the animal organism has not yet been definitely demonstrated except in certain detoxications. It is obviously of importance to ascertain if there is any evidence of the existence of similar mechanisms in germinating seedlings in which amide synthesis is a well-established fact.

Dehydrogenase activity was tested for by the Thunberg's methylene blue technique. M/10 solutions of the following amino-acids were used as substrates: glycine, *l* (+)-alanine, *l* (—)-leucine, *l* (—)-histidine, *l* (—)-tyrosine, *l* (—)-aspartic acid, and *l* (+)-glutamic acid. The experimental material was prepared by grinding up two days' old seedlings with 0·87 % dipotassium phosphate, pressing through muslin and centrifuging the extract.

It was found that the only amino-acids that have a definite accelerating action on the reduction of methylene blue by the extracts are glutamic acid and alanine. The following table shows the results of a typical experiment with the seedlings of *Phaseolus mungo* (green gram). The times given are for the decolourisation of 0·5 ml. of a 1/5000 solution of methylene blue by 0·5 ml. of the plant extract in the presence of 0·2 ml. of M/10 amino-acids.

Substrate added		Period of decolourisation
0.2 ml. Glutamic acid	..	7 mins.
0.2 ml. Alanine	..	10 mins.
No substrate	..	16 mins.

The effect of alanine is not sufficiently marked, the Thunberg factor "I" being less than one, to infer with certainty the existence of a specific dehydrogenase for this amino-acid. Even the glutamic acid dehydrogenase is limited in its distribution, it being found only in three out of the seedlings of several species examined, *viz.*, in *Phaseolus mungo* (green gram), *Phaseolus radiatus* (black gram), and *Pisum sativum* (pea). From extracts of two day old seedlings of these species, the dehydrogenase can be obtained in cell-free solution by filtration of the centrifuged extract through paper pulp. The optimal reaction for the action of the enzyme is pH 7·8, while below pH 5·8 it has no activity. Manometric experiments show that the enzyme is capable of oxidising glutamic acid in the presence of molecular oxygen also. The products of oxidation as well as the connection of the enzyme, if any, with glutamine formation are being investigated.

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K. RAMAKRISHNAN NAIR.
University Biochemical Laboratory,
Chepauk, Madras,
August 17, 1936.

1 Krebs, *Biochem. J.*, 1935, **29**, 1951.
2 Bernheim and Bernheim, *J. Biol. Chem.*, 1932, **96**, 325; 1934, **106**, 79; 1934, **107**, 275.
3 Krebs, *Biochem. J.*, 1935, **29**, 1620.
4 Weil-Malherbe, *Biochem. J.*, 1936, **30**, 665.

Relative Digestibility of Caseins in their Artificial and Natural Environments.

AN ultra-microscopic study of milks from various species of animals reveals large differences in the dispersion of casein particles. Of the milks examined so far the buffaloe's milk has the lowest dispersion of casein while that from the ass has its casein dispersed to the highest extent. The albumin content of a milk generally increases with the extent of dispersion of its casein particles, the higher the dispersion the greater the albumin content. Ass's milk possesses the highest amount of albumin, thereby offering effective protection to the highly dispersed casein particles.

From the point of view of digestion it is reasonable to expect a higher digestibility in the case of milks which exhibit a higher dispersion of their proteins. A comparative study of the *in vitro* digestion of milks from the cow and the ass, has shown that ass's milk is about one and a half times more digestible than that of the cow. It was of interest to determine if the caseins prepared from their respective milks continued to

maintain their digestibilities when they were redispersed in an artificial environment (phosphate buffer). In the course of this experiment, many interesting points of difference between the two caseins, revealed themselves. As compared with cow's casein it was difficult to redisperse the casein from ass's milk in the M/15 phosphate buffer (pH 7·7); and it is therefore clear that although the same buffer and the same concentration of the two caseins were used for the digestion experiments, the substrates were, therefore, not dispersed to the same extent. Ass's casein is much harder and denser than cow's casein prepared and purified under the same conditions. The casein particle in ass's milk exhibits a powerful tendency to aggregate and the exceptionally high ratio of albumin to casein (1 : 2) is Nature's provision to protect the highly dispersed casein particles and keep them from coalescing.

It has been found that the rate of digestion of albumin from ass's milk is only a fifth of the rate at which ass's casein is digested. This circumstance is of great importance from the point of view of digestion of the casein particle since the albumin continues to offer colloidal protection until the casein attains a reasonably advanced stage of degradation.

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September 14, 1936.

An Ageotropic Mutation in X-Rayed Rice.

IN the course of studies on the mutations obtained in X-rayed rice, a plant with a prostrate habit was isolated in the second generation of plants raised from one of the pure lines, Co. 4, the dry seeds of which had been exposed to X-rays for one hour under a Coolidge tube with copper anti-cathode operated at 53 kv. and a tube current of 10–11 m.a. at a target distance of 17 cm. without filter. Only a few seeds were obtained from this plant as by the habit of the plant, most of the seeds had fallen into the field. The seedlings raised from the seeds in the usual swampy seed-bed were of two kinds, the natural erect ones and the prostrate ones like the parent. In the prostrate type the inclination of the shoots did not present any regularity as it was in all directions. The seedlings were later transplanted in regular plots. Generally rice seedlings grow erect after they strike root, which will be in about a week after transplantation. In this particular progeny it was found that while many of the seedlings were growing in an inclined direction, some were like the normal seedlings growing erect. The segregation was a mono-hybrid one, indicating the dominance of the prostrate habit.

	Observed	Expected (3 : 1)
Prostrate ..	28	30
Erect ..	12	10

$$\frac{\text{Dev.}}{\text{S.E.}} = 0\cdot 72.$$

These prostrate plants are unique and are different from the type described by Ramiah (1930) where the prostrate habit of the plant was due to the spreading nature of the tillers. During the heading time, the tillers bend at the nodes and become erect and later on again assume a spreading habit at maturity. The type described here, on the other hand, presents an appearance of a plant completely or partially lodged without any bending or curving in any of the nodes against gravity. It resembles the 'lazy' plant described by Jenkins and Gerhardt (1931) in maize where the prostrate nature of the plant was suggested by Eyster (1934) and later on by Overbeek (1936) as due to the stem being '*ageotropic*' or gravitationally indifferent.

Seeds of one of this prostrate plant and of the normal Co. 4 strain from which this mutation arose, were sown in a line centrally, each in a separate pot. As soon as the tip of the seedlings were visible above the surface of the soil, both the pots were tilted and kept in a horizontal position with the soil surface vertical. While the seedlings from the prostrate plant grew horizontally, the normal seedlings curved up and grew vertically (Fig. 1). In another set both the pots were hung inverted, top downwards soon after germination. The prostrate plant progeny grew downwards while the normal seedlings bent flat in their attempt to grow vertically upwards against gravity.

Fig. 2 shows the same control and prostrate progenies sown in a pot and allowed to grow without any change in the position of the pot. While the seedlings of the control are erect, those of the prostrate show inclination to the vertical. This inclination is more enhanced if these are raised in wet seed-bed.

The progeny of all the plants both erect

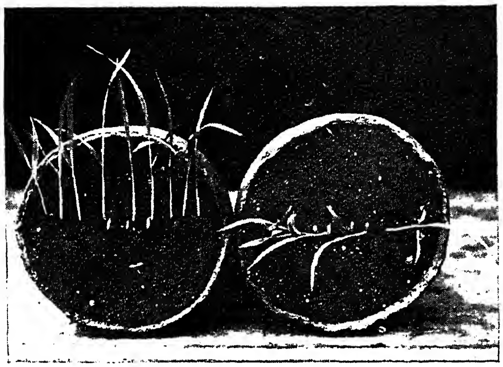

Fig. 1.

Normal Seedlings. Ageotropic Seedlings.

Fig. 2.

and prostrate are being grown this season for confirmation of their behaviour in inheritance. While in the case of maize, the gene for '*lazy*' is a simple mendelian recessive, in this case with rice it appears to be a simple dominant. The fact that parallel mutations are in some cases dominant and in other cases recessive is still mysterious and requires investigation. Studies on the response of this ageotropic mutant to light are under progress.

Though the mutation described above was derived from the material that was subjected to X-rays the possibilities of such a mutation occurring independently in nature are not entirely ruled out but so far as the authors are aware no record has been made of such a mutation occuring in rice.

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N. PARTHASARATHI.

Agricultural Department,
Coimbatore,
August 17, 1936.

Eyster, W. H., *Bibliographica genetica*, 1934, **9**, 215.
Jenkins, M. T., and Gerhardt, *Ag. Expt. St. Iowa, Stat. Coll. Bull.*, 1931, **138**, 123.
Overbeek, Van Y., *Jour. Heredity.*, 1936, **27**, 93–96.
Ramiah, K., *Mem. Dept. Ag.*, 1930, **18**, 212.

Visibility of Ultrasonc Waves in Liquids.

THE theory regarding the visibility of ultrasonic waves as given by N. S. Nagendra Nath, which is under publication in the *Proceedings of the Indian Accademy of Sciences* for September, has been verified by me in this laboratory.

The earliest observations were made by Hiedemann and his collaborators at Köln, and later by Bär at Zurich. Parallel monochromatic light falls on one face of a cell containing a liquid through which ultrasonic waves of frequency $7 \cdot 164 \times 10^6$ c./s. are passed. On the opposite face a microscope is placed, focussed on the optical grating formed by the sound waves. Stationary waves were used throughout.

The grating pattern of the field was obtained for one position very near the cell and the pattern repeated itself on moving the microscope through a distance corresponding to $d = \frac{\lambda^{*2}}{2\lambda}$ where λ^* and λ are the wave-lengths of sound and light respectively. Even at multiples of this distance, there was repetition of the pattern. This is in conformity with the theory put forward by Nath for the periodicity of the phenomenon and observed for the first time.

It was also noticed that at exactly half the distance required for the pattern to repeat, the fringes observed were doubled. At all other positions of the microscope only a constant intensity of the field was observed. This periodicity of the phenomenon gives yet another method for determining the velocity of sound in a liquid very accurately, for if we know d and λ, λ^* and hence v the velocity of sound can be calculated from the known frequency of vibration of the quartz. Thus for the frequency $7 \cdot 164 \times 10^6$ c./s. the velocity of sound for the following liquids were obtained:

Benzene	..	1302 m./s.	at 25° C.
CCl_4	..	918 m./s.	,,
m-xylene	..	1320 m./s.	,,
and Anisol	..	1441 m./s.	,,

S. PARTHASARATHY.

Indian Institute of Science,
Bangalore,
September 22, 1936.

REVIEWS.

Dielectric Phenomena in High Voltage Cables. By D. M. Robinson. (Chapman & Hall, London), 1936. Pp. 137. Price 15*sh.*

This book deals with what must have appeared to be one of the most obscure subjects ever confronting applied science. It does not deal "with the art of the cable-maker nor with the processes involved" which is rather surprising in spite of the title but the subject-matter forms a fascinating account of the problems arising in connection with paper insulated cables and the way in which the different methods of failure have been identified and classified, and the various causes of failure have been brought to light.

Perhaps, the most arresting feature of cable-making is the multitude and complexity of the problems arising from such an apparently simple contrivance as a conductor insulated with paper and sheathed with lead and the enormous amount of investigation work arising from them. This work has invaded all fields of science such as the metallurgy of lead and copper, the chemistry of rubber and oils while an idea of the extensive detail of the investigators may be gleaned from the extent of work done on wire-drawing alone—under this heading has been studied the deformation and change of stress distribution with the number of passes through the die, the life of the die in connection with the lubricant used and, unless we are mistaken, the discovery of Boron Chloride, the hardest material known, is a by-product of cable research.

The production and application of the armouring alone has led to an extraordinary amount of work in the production of flawless sheaths, methods of excluding oxide, corrosion effects, machines for applying the sheath and to such abstruse subjects as atmospheric action on fatigue phenomena.

With regard to the dielectric the main problems have naturally centred round the different modes of breakdown which may be divided into two main classes, the "carbon track" breakdown and failure due to "thermal instability". The former consists of a carbon track (treeing) which slowly forms in the course of a long time from a point near the conductor and takes an oblique path towards the sheath. It has been fairly well established that it has its origin in the ionisation which takes place in any small space (technically termed "void" but this does not necessarily signify an empty space) near the conductor which produces some carbonisation due to oxidation of the oil and the spread of which the paper alone is not able to stop.

The other type of failure is due to the rate of heat production by the dielectric loss in relation to the capacity of the cable to dissipate the heat. If then the power factor of the dielectric increases with temperature the conditions may be such that the temperature continues to rise until the insulation becomes charred and breakdown takes place. This type of fault is characterised by a small hole passing radially from the conductor to the sheath, the condition after breakdown depending on the power of the fault arc. In this connection the heat conducting properties of the soil or other surroundings of the cable frequently outweigh those of the cable itself.

In addition to these two distinct causes there are, as one might expect, mixtures of the two, the heat involved by the tracking mechanism may be sufficient to cause local thermal instability. This probably made the original separation into the two classes very difficult. This classification leaves out of consideration failures of the type called "Disruptive" or by the more accurate name "Puncture Breakdown" as this type clearly stands in a class by itself.

An enormous amount of ingenuity has been displayed in the experimental work on cables not the least being the production of "arrested failures" and the testing technique employed which, in view of the long time element involved in full scale testing must be made to imitate, by shorter period tests, the effects produced in service. The Schering bridge which was first applied to cable investigation about 1922 does not give information about definite localities but its use has been of great service in cable manufacture and good results followed immediately from the first applications of it. The Magneta Wax Test has been of the greatest service in making visible the effects of tracking by showing up the wax residue resulting from the oxidation of the oil.

Again, clever testing technique has enabled two workers recently to establish that power factor and oxidation considered radially through the dielectric follow a U-shaped curve.

Since the carbon-tracking failure results from ionisation it might be expected that the gas pressure and kind of applied voltage whether d.c., a.c. or surge and the frequency in the case of a.c. would have considerable effects on the result.

Recent work on the subject includes the fundamental properties of paper as a dielectric once again and of paper in relation to moisture content while the dielectric loss in paper and oil separately and the peculiar difference between their separate properties and those of the combination are matters of continuous work.

Apart from the practical utility of the book to cable users in general the chief interest of the book to the ordinary man of science is twofold, first in the fact that so much of the work is pure physics (or would be except that the final object of it is industrial production) and secondly the comparison between modern theories, particularly his own and the author's, on the behaviour and properties of dielectrics and their application to practice. In spite of the fact that the author acknowledges only meagre benefit from the vast amount of attention by scientists to laboratory dielectrics one cannot help but feel that the cable makers must have profited to quite a considerable extent from the general ideas enunciated by the theoretical physicists. On the other hand of course pure scientists are not likely to impose on themselves such limitations as the necessity for rolling on a drum of 5 or 10′ diameter which, in the case of a cable of about 2″ diameter, is a serious matter indeed. In addition the interest of cable users will centre round the author's remarks on the routine testing of cables. Often it happens that one of the greatest difficulties of manufacturers is to persuade the purchaser to accept tests which are suitable to the occasion, which are sufficient for the purpose and which still impose no permanent injury on the apparatus.

An interesting item of news in connection with this subject is the recent installation in Paris of a cable for 220 kilovolts and 160,000 k.v.a.

Our Enemy the Termite. By T. E. Snyder. (Comstock Publishing Co., Ithaca, New York), 1935. Pp. xii + 196. Price 3 dollars.

For what is probably the first time, co-ordinated information about the termites has been presented in this book with the forbidding title. So many fallacies have crept into popular accounts of these animals that the time has arrived for scientific truth to step in and check their growth and spreading. The author who has been associated with the Bureau of Entomology, United States Department of Agriculture, has studied termites for over twenty-six years and has collected valuable information about their habits, their structure, their distribution and their life-history.

Very naturally, the termites of the American continent have come in for fuller treatment and the author expresses the encouraging hope that the undiscovered species of termites are far greater in number than those described so far. The book can be neatly divided into two sections, the first, of six chapters, containing information about the termites from a biologist's point of view, while the second, of four chapters, is in itself, a treatise on the economic aspects of termite life.

The original home of the termite was probably the jungle and the author holds man responsible for their advent into towns and civilised habitations. Extensive deforestation, conversion of thick jungle to form plantations and acquirement of large tracts of virgin forest for man's use, have resulted in ousting the termite from its natural habitat so much so that it threatens to be one of man's serious insect pests. One would be greatly fascinated but deeply perturbed at the extremely catholic taste of termites, practically every article under the sun forming the object of their attention.

A refreshing thing is to note that the author is not the type of abstract scientist so common all over the world. In a problem of this type, the close bearing of termite life with that of man's, is the first to be recognised and Dr. Snyder has devoted much space and attention to constructive methods of control and remedy of this pest.

It is impossible to make the book more interesting than what it is. Dr. Snyder has many stories to tell of the great hardship he has endured during the course of his twenty-six year study but he has come

unscathed,—indeed, has brought out a work of supreme value to the naturalist, to the building contractor, to the forest engineer and to every citizen. The numerous figures illustrating the book are eloquent proof of the thoroughness of the author's efforts and the usefulness of the work is considerably heightened by a glossary and an index.

B. R. S.

Survey of India Geodetic Report for 1935. (Published by the Director, Geodetic Branch, Survey of India, Dehra Dun), 1936. Pp. 101 + xxxvii with 20 charts. Price Rs. 3 or 5*s.* 3*d.*

The volume under review is a report of the activities of the Geodetic Branch of the Survey of India during the year 1934–35.

The book covers a wide and varied field. Chapter I is on Triangulation containing a report on the measurement of primary series of triangulation carried out during the year, to replace the Assam Valley Series. In all, observations were made at thirty stations, use being made of the old stations in the Assam Valley, with two new stations in the Mikir Hills and a few in the administered Naga Hills. At each station, two days and a night and more often two whole periods of 24 hours were found necessary for carrying out the observations. Chapter II deals with an account of the progress made on high precision level net. The precise levelling was also done on the Bagaha-Sironj line with a view to correct the main line of levels affected by the Great Bihar Earthquake to Sironj, on the stable part of the Peninsula. But levelling was carried only as far as Ghazipur, the heights of Bench Marks at Bagaha showing a rise of $1\frac{1}{4}$ to $1\frac{1}{2}$ feet as determined just after the earthquake in 1934 and from Gorakhpur to Ghazipur showing a rise of about $\frac{1}{2}$ foot. But it will not be possible to determine what changes in levels have taken place prior to the completion of this line of levels. Chapter III is a report on the Deviations of the Vertical. Both Components of the deviations of the vertical were measured at 107 stations in Baluchistan and between Orissa and Rajputana. The meridional Component of the deviation was also measured at 34 stations along a line from near Hyderabad (Deccan) to Agra. This work completes the main east to west geoidal section across India and Burma and the north to south section in India. Revised Geoidal Charts have been prepared. Chapter IV deals with the Gravity Survey made at 33 stations extending from north of Bombay to Cutch and Rajputana; the observations consisting of 3 sets of duration from 6 to 10 hours each, between time signals. The results add considerably to our knowledge of the tectonic structure of this part of the Peninsula. Chapter V is devoted to an account of the Geophysical Survey in Bihar. Gravity observations with the pendulum, showing only the main tectonic downwarps and upwarps was found unsuitable to more detailed investigation necessary for the determination of the configuration of the bed rocks underlying alluvium. Hence a preliminary investigation was undertaken using both gravimetric (torsion balance) and magnetic methods of geophysical exploration over the same line of country from Nepal boundary due south to just west of Motihari. The result of the survey indicates the possibility of successful delineation of the buried features which is essential to adopt methods of protection against earthquakes. Work done in the computing office and in the Tidal Section is dealt with in Chapter VI. Apart from the preparations of the usual Tide Tables for the Indian Ocean for the year, at the request of the International Association of Physical Oceanography, the monthly and yearly values of mean sea-level at Bombay from 1878 (the first year of available data) to 1930 have been computed by the Tidal Section. The data do not show any progressive change of sea-level relative to the land at Bombay during this period. The results of the International Commission are likely to be of considerable interest. Chapter VII is an account of the work done at the Dehra Dun Observatory. The usual bi-weekly observations for time were made during the year with the motor and shutter transits. The short and Riefler Clocks have been equipped with batteries of Edison Soda Cells with a view to stop failures or irregularities due to battery charges. The regular magnetic, meteorological and seismographical observations have been carried out as usual. The last chapter contains some notes on the changes of level in Bengal by Mr. B. L. Gulatee, M.A. (Cantab.). The question of rise of level in Bengal as compared with Calcutta is considered afresh in the light of levels from Karachi. Rise of Benares is only indicated by lines from Howrah; all other lines available so far, tend to show that both Benares and Agra

have remained stable. The conclusion from an examination of the various level nets is against the supposed rise.

Every chapter in the volume is accompanied by a number of charts and tables prepared with great care. Special attention has to be drawn to some of the sections which are of outstanding interest. Geophysical Survey in Bihar is a pressing need and full of possible future utility in that, that it may throw light on the needs of the locality for protection against subsequent earthquakes. The question of constancy of sea-level is also of considerable interest. Colonel Walker, Superintendent, Great Trigonometrical Survey, has long ago referred to a correlation between mean sea-level and barometric pressure and now further attention has been drawn in the *Comptes Rendus de l' Academie des Sciences* to the connection between mean sea-levels and meteorological conditions by Mr. M. Jean Legrad who has shown a relationship between mean sea-level in the Meditterranean Sea and rainfall in Abyssinia. We learn from the Report that he is now being supplied with the mean sea data relating to Aden and other ports and the result of his researches will no doubt be awaited with interest.

The volume deserves a wide circulation among surveyors, engineers and other scientists and will surely be a good addition to any library, containing as it does, a mass of valuable information, the result of a year's strenuous activity of the Geodetic Branch of the Survey of India.

C. G.

Statistical Methods and their Application to Agronomy—A Bibliography. Compiled by K. K. Guha Roy, B.A., with additions by P. C. Mahalanobis, M.A., I.E.S. (Miscellaneous Bulletin No. 9 of the Imperial Council of Agricultural Research, Delhi), 1936. Pp. 120. Price Rs. 2–2 or 4*s*.

Agricultural research workers engaged in problems involving the aid of modern developments in statistical theory will welcome this bibliography. It consists of two parts. The first gives a list of statistical books including some important tables as those of Karl Pearson's. In the second part are three sections. The first section gives references to papers dealing with mathematical theory, namely, averages and variance, correlations, frequency curves, goodness of fit, etc. The second part gives references to papers where their principles are applied as in field trials, meteorological research, genetics and other fields of research. The third section is an addendum.

The authors confess that exhaustiveness was not their chief aim. Here is a record of some references found in some journals in the Pusa library with additions made from the Statistical Laboratory at Calcutta. The purpose of a bibliography is two-fold. It enables research workers to avoid a repetition of work already completed elsewhere, and at the same time provides help to those seeking light on some definite problems. Therefore one would consider exhaustiveness the chief merit of any bibliography. It is hoped that this preliminary edition will be quickly followed up by an exhaustive bibliography.

D. S. R.

Biréfringence Magnétique de l'Oxygène liquide, de l'Azote liquide et de leurs Mélanges. Par P. Lainé. (No. 324 of the Actualités scientifiques et industrielles.) (Hermann et Cie, Paris), 1936. Pp. 55. Price 15 *fr*.

This is an account of the experiments made by the author on the magnetic birefringence of liquid oxygen and liquid nitrogen and their mixtures, using the large Bellevue electromagnet. The experimental arrangement is briefly described. The result found is that the variation of the magnetic birefringence of liquid oxygen varies as $1/T^2$ as required by Langevin's theory (T is the absolute temperature). But the magnitude of the Cotton-Mouton constant comes out too small and since the Leyden investigators have found that the variation of the susceptibility does not follow the $1/T$ law predicted by Langevin's theory, the author proposes a new explanation. The theories of G. N. Lewis and of Rocard and Goldstein to account for the Leyden results are criticised and a new hypothesis is advanced based on the assumption of the validity of Boltzmann's law of distribution and of the existence of oxygen in three different states with the spins -1, 0 and $+1$ and also the presence of the polymer O_4 in different concentrations at different temperatures. Further experiments to test this hypothesis are suggested. The results are interesting and of importance, but since a fuller account is promised in the *Annales de Physique*, the present mode of publication seems to be a departure from ordinary practice.

Le Deutérium ou Hydrogène lourd. Deuxième Partie. Par E. Darmois. (No. 344 of the Actualités scientifiques et industrielles.) (Hermann et Cie, Paris), 1936. Pp. 40. Price 10 *fr.*

This is a resumé of the new results that have been obtained since the first part was published in the same series. The physical and chemical properties of deuterium and of its compounds are discussed in relation to those of hydrogen and its compounds. In spite of the catalogue-like nature of the subject the presentation is lively and interesting. But there are some errors which should be eliminated from a book of reference such as this brochure is intended to be. Thus in the table on p. 12 the latent heat of fusion of DCl is given as 141 cals./Mol and that of HCl as 476 whereas 476 is the value for DCl and that of HCl is 498·2. The magnetic moment of the deuton is said to be 1/5 that of the proton while Kalckar and Teller and Farkas and Farkas have shown the ratio to be $\frac{1}{4}$. On p. 15 we find, v_1, v_2, v_3 for ν_1, ν_2, ν_3. On the same page the symbol Be for the band constant usually designated B_e may cause confusion with the symbol for Beryllium. The elimination of these and a few other typographical errors will increase the usefulness of the pamphlet.

Chaleur Spécifique et Théorie des Quanta. Par Prof. Chr. Musceleanu. In two parts. (Nos. 321 and 322 of the Actualités scientifiques et industrielles.) (Hermann et Cie, Paris), 1936. Première Partie—Pp. 49, Price 15 *fr.* Deuxième Partie,—Pp. 35, Price 12 *fr.*

The two monographs give a resumé of the theory of specific heats, commencing with Thermodynamics, and Kinetic Theory and the Equipartition theorem, and going on to the quantum theories of Einstein, Nernst and Lindemann, and Debye. The elements of Statistical Mechanics are introduced to deduce Planck's expression for the energy of an oscillator. The ground covered is that usually found in text-books but the addition of a few pages on Born and Karmán's theory of the specific heat of crystals is an important asset for the book. The presentation is good but occasionally roundabout methods are employed. We are pained to find misprints on every page without exception. If these are removed, the books will provide profitable reading.

Les Théories Quantiques. Par René Arditti. (No. 330 of the Actualités scientifiques et industrielles.) (Hermann et Cie, Paris), 1936. Pp. 33. Price 8 *fr.*

This is the substance of a lecture delivered at the Conservatoire national des Arts et Métiers on the quantum theory of valency. Bohr's theory of the atom and Pauli's principle in its application to the Periodic Table occupy about half the book and then the wave equation is introduced and the idea of quantum mechanical resonance is explained. The theory of valency is then briefly and qualitatively expounded. This would serve as a useful introduction but for the numerous mistakes in the book. Thus Bohr's frequency condition is stated to be $\nu = \frac{E_p - E_q}{nh}$ with n an integer. On the same page the quantification of the minor axis of the elliptic orbit is said to result from relativistic considerations, while the precession of the major axis is ascribed to the movement of the electron and proton round their centre of gravity as contrasted with the motion of the electron round the nucleus. The spin s is said to have the values $\frac{1}{2}$ and $-\frac{1}{2}$ and m stands for m_l. In the Schrödinger equation on page 17, the factor m is missing. The dissociation energy D is given in volts per cm. We find Polaniy for Polanyi and van t' Hoff for van't Hoff. On the whole the volume does little credit to the series in which it appears.

Activité et Interaction Ionique. I.—Expose Theorique. II.—Experimentale de l'Activite des sels de Metaux lourds. By M. Quentin. (Actualités Scientifiques et Industrielles.) (Hermann and Cie, Paris), 1935, No. 309—Pp. 33, Price 8 *fr.* No. 310—Pp. 90, Price 18 *fr.*

The first monograph gives a clear exposition of Debye and Huckel's theory of strong electrolytes, the approximations used in the same, and the subsequent developments of the theory by Bjerrum and by Gronwall and La Mer to take account of the deviations between theory and experiment. The second number gives an account in detail of the author's experiments on the activity of the salts of heavy metals which can be regarded as intermediate between strong and weak electrolytes. In calculating the mean activity of a salt the majority of workers assume for the sake of simplicity that the radius

'*a*', the parameter in Debye's theory, is the same for each ion. This assumption has no basis, and indeed the author finds that for $CdCl_2$, the values are different for the cadmium and the chlorine ions. The values of the mean coefficient of activity at different concentrations show that the relative departure from Debye-Huckel's theory passes through a maximum at what are usually considered as very dilute solutions: thus, for $CuSO_4$, it is 40% at 0·001 M, and 6% at 0·1 M. The results are further discussed in relation to the formula of Cromwell and Lamer and of Bjerrum, and the existence of incomplete dissociation.

The two monographs together keep up the usual standard of the Actualite series.

M. A. G.

Mathematics for Technical and Vocational Schools. By Samuel Slade and Louis Margolis. (John Wiley & Sons, Inc., New York; Chapman and Hall, Ltd., London), 1936. Second Edition. Pp. 517. Price 12*s*. 6*d*.

All progressive countries in the world, in which a constructive system of education is in vogue, have of late developed their own systems of vocational and technical training. With the rapid growth of trade and industry, the need for imparting technical education in suitably equipped schools has been increasingly felt, as a result of which, the number of such schools is increasing every year. It has been rightly felt that no knowledge of modern industry is sound, without a clear understanding of the mathematical and scientific principles, on which the essential parts of the various machinery employed in the factory and the mechanical shop are based and constructed; at the same time it is important to see that the student in the vocational school is not burdened with unnecessary and elaborate details of mathematics or theoretical science. Such portions of mathematics as are useful to the student of vocational education, will have to be sifted out and properly knit together in logical sequence in a clear and understandable manner. Judged from this point of view, the authors have achieved a large measure of success.

The aim of the authors has been to "produce a practical working text-book on mathematics as applied to technical and trade work, the aim being to teach the pupil how to solve the problems that occur in his work." Theoretical discussion and derivation of formulas, etc., have been minimised. The portions dealt with include useful matter from Arithmetic, Algebra, Geometry, Trigonometry, Dynamics and Statics. A large number of examples of every-day interest and use have been given. The explanations are clear and lucid and adequately illustrated. The treatment is designed to meet the needs of the pupil dealing with machine-shop problems; this is clearly understood, when it is mentioned that the twenty-four chapters comprising the book deal with such topics as mensuration, practical computation, slide rule, strength of materials, windmills, speed ratio of pulleys and gears, screw threads, etc. There is no doubt that the book will serve a very useful purpose. The large number of useful tables given at the end of the book will serve to enhance the usefulness of the book. We unhesitatingly recommend it as a text-book for use in the technical high schools that are rapidly springing up in this country.

La masse en cinématique et théorie des tenseurs du second ordre. By Ch. Platrier. (Actualités scientifiques et Industrielles, No. 326.) (Hermann et Cie, Paris), 1936. Pp. 81. Price 18 *fr*.

This volume is the second of a series of three books written by the author on the science of kinematics which is one of the important branches of the mechanics of rigid, and deformable bodies. The subject-matter is the substance of lectures delivered by the author to the students of the Technical College of France. The third chapter of the book is very instructive and it is well written and gives an account of the elementary notions of the tensors of second order. The fourth chapter deals with the moments and products of inertia and the remaining five chapters are mainly devoted to theorems of Koenig on the laws of kinematics and to some of their important applications. The book may be considered to be a good introductory volume to the study of more advanced vectorial mechanics. As far as possible the classical method has been avoided and vectors and tensors are used freely throughout the book. Though the subject-matter is elementary, the treatment is modern and the exposition is quite lucid and illuminating.

M. N. N.

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THE PRESIDENTIAL ADDRESS.

THE IMPACT OF SCIENCE UPON SOCIETY.

BY SIR JOSIAH STAMP, G.C.B., G.B.E., LL.D., SC.D., D.SC., F.B.A.

DURING the past year we have had to mourn the loss of our Patron, King George V, but to rejoice in the honour done us by His Majesty King Edward VIII, himself our most illustrious past President, in taking that office.

Since the beginning of this century the British Association has, till now, added only one new place of meeting in this country to its list. Blackpool can certainly do for science in the North all that Bournemouth achieved in the South: give our record new vigour and itself a new friend.

The reactions of society to science have haunted our presidential addresses with various misgivings for some years past. In his great centenary address General Smuts, answering the question 'What sort of a world picture is science leading to?' declared that one of the great tasks before the human race is to link up science with ethical values and thus to remove grave dangers threatening our future. For rapid scientific advance confronts a stationary ethical development, and science itself must find its most difficult task in closing a gap which threatens disruption of our civilisation, and must become the most effective drive towards ethical values. In the following year a great Engineer spoke as a disillusioned man, who watched the sweeping pageant of discovery and invention in which he used to take unbounded delight, and concluded by deploring the risk of losing that inestimable blessing, the necessity of toil and the joy of craftsmanship, declaring that spiritual betterment was necessary to balance the world. Then came the President of the Royal Society, a supreme Biochemist, on the perils of a leisure made by science for a world unready for it, and the necessity for planning future adjustment in social reconstructions. Followed the Astronomer, deploring man's lack of moral self-control; in knowledge man stands on the shoulders of his predecessor, whereas in moral nature they are on the same ground. The wreck of civilisation is to be avoided by more and not by less science. Lastly, the Geologist gloried in the greatest marvel of millions of centuries of development, the brain of man, with a cost in time and energy that shows us to be far from the end of a mighty purpose, and looking forward confidently to that further advance which alone can justify the design and skill lavished on such a task. So the Geologist pleads then

for scientific attention to man's mind. He has the same faith in the permanence of man's mind through the infinite range of years

'Which oft hath swept this toiling race of men
And all its laboured monuments away,'

that is shown at the Grand Canyon, where, at the point exposing, in one single view, over a billion and a half years of the world's geological history, a tablet is put to the memory of Stephen Tyng Mather, the founder of the National Park Service, bearing what is surely the most astonishing scientific expression of faith ever so inscribed:

'There will *never come an end* to the good that he has done.'

We have been pleading then in turn for ethical values, for spiritual betterment, for right leisure, for moral advance, and for mental development, to co-ordinate change in man himself with every degree of advance in natural science in such a harmony that we may at last call it Progress. This extension of our deeper concern beyond our main concern is not really new, but it has taken a new direction. I find that exactly one hundred years ago there was a full discussion of the moral aspects, a protest that physical science was not indeed, as many alleged, taking up so much of the attention of the public as to arrest its study of the mind, of literature and the arts; and a round declaration that by rescuing scientists from the narrowness of mind which is the consequence of limiting themselves to the details of a single science, the Association was rendering 'the prevailing taste of the time more subservient to mental culture'. A study of these early addresses shows that we are more diffident to-day in displaying the emotions and ideals by which I do not doubt we are all still really moved. But they also show that we are pre-occupied to-day with some of the results of scientific discovery of which they were certainly then only dimly conscious. A part of that field, which ought itself to become scientific, is my theme to-day.

What do we mean by impact? My subject is *not* the influence or effect of science upon society—too vast, varied and indeterminate for such an occasion. We may consider the position of the average man, along a line of change we call 'progress,' at the beginning of a certain interval of time and at its end. We might then analyse how much is due to a change in the average man himself, his innate physical and mental powers, and how much to other influences and particularly to science. We may debate whether the distance covered is great or small by some assumed standard, and whether progress has been rapid. We might ask whether the direction has been right, whether he is happier or better—judged again by some accepted standard. But our concern here is with none of these questions. I ask whether the transition has been difficult and distressing, in painful jerks and uprootings, costly, unwilling, or unjust; or whether it has been easy, natural, and undisturbing. Does society make heavy weather of these changes, or does it, as the policeman would say, 'come quietly'? The attitude of mind of our order may be either that change is an interruption of rest and stability, or that rest and stability are a mere pause in a constant process of change. But these alternatives make all the difference to its accommodating mechanisms. In one case there will be well-developed tentacles, grappling irons, anchorages, and all the apparatus of security. In the other, society will put on casters and roller bearings, cushions, and all the aids to painless transition. The *impact* of science will be surprising and painful in the one case, and smooth and undamaging in the other. Whatever may be the verdict of the past, is society and its institutions now learning that change is to be a continuous function, and that meeting it requires the development of a technique of its own?

Science itself has usually no immediate impact upon institutions, constitutions and philosophies of government and social relations. But its *effects* on people's numbers, location and habits soon have; and the resistance and repugnance shown by these institutions and constitutions to the changed needs may rebound or react through those effects upon scientific enterprise itself and make it more precarious or more difficult. Thus the effect of applications of electricity and transport improvements is clearly to make the original areal extent of city or provincial governments quite inappropriate, and the division of functions and methods of administration archaic. If these resist

change unduly they make it more difficult and frictional, and the applications of science less profitable and less readily acceptable. Time makes ancient good uncouth. When two bodies are violent or ungainly in impact, both may be damaged. If the written constitution of the United States, devised for the 'horse and buggy' days, still proves not to be amenable to adjustment for such demands, it will be difficult to overstate the repercussion upon economic developments and the scientific enterprise that originates them. Let the Supreme Court Decision of unconstitutionality on the Tennessee Valley experiment in large scale applied science to natural problems on a co-ordinated plan bear witness. Such unnecessary resistance may be responsible for much of what has been aptly called 'the frustration of science'. Avoidable friction in the reception given to scientific discovery not only deprives the community of advantages it might otherwise have enjoyed much earlier, or creates a heavy balance of cost on their adoption; it may also discourage applied science itself, making it a less attractive and worthwhile pursuit. In that sense we are considering also the impact of society upon science. This too is not new. The Association had as one of its first objects 'to obtain a more general attention to the objects of Science, and a removal of any disadvantages of a public kind which impede its progress.' The first address ever offered affirmed that the most effectual method of promoting science was the removal of the obstacles opposing its progress, and the President instanced the very serious obstacles in the science of optics due to the regulations relating to the manufacture of glass. To-day perhaps the scientist places more stress upon the failure of governments to encourage, than upon their tendency to discourage. So much then for the *idea* of impact. Is the scientist or inventor responsible for impact, and if not, who is ?

Elsewhere I have retouched Jeremy Bentham's poignant picture of the inventor of over a century ago, plans and cap in hand, on the doorstep of the rich or influential, waiting for someone to believe in him. From this type of external 'sport' amongst engineers and scientists came much or most industrial innovation, external to the process of business. To-day, in the older and applied sciences affecting industry the solo scientist is the exception and, with the large research departments of particular businesses and trade research associations, the picture is quite different—the expenditure higher, but the results much more rapid and numerous even if for a time they may be kept secret. Although records of finished work may be available over the civilised world, there is much overlapping of current work, but the price of this as a whole is a far smaller fraction of the total result, if we omit from our consideration the first magnitude discoveries of epoch-making influence. The industrial community is now far more amenable than hitherto to scientific influence, indeed it is often the instigator in the mass of minor advances. The new epoch of concerted industrial research dates really from the end of the Great War. During all that time I have held some middle position of responsibility between the research laboratories and institutes on the one hand, and the costing and profit and loss accounts on the other, and my impression is that the proportion of work in which the initiation comes from the business end is steadily increasing. In studies of the periods of scientific and industrial gestation respectively, I have elsewhere defined *scientific gestation* as the time elapsing between the first concept of the idea and its public presentation to society in a form substantially that in which it ultimately finds extensive use without important modification; and *industrial gestation* as the period elapsing from this point to the date when in an economic or industrial sense the innovation is effective. Both periods are difficult to determine exactly in practice, but on a broad view, the period of industrial gestation, with which alone I am here concerned, appears to me certainly to have shortened materially, though possibly at greater social cost. It would obviously be so if industry is actively encouraging research. 'Faraday's discoveries came at the beginning of the great steam era, and for fifty years there would have been no difference in transport even if those discoveries had not been made,' for the telegraph was the only material influence upon it, and practical lighting was delayed till 1900.

In nearly every scientific field there is sub-division of labour, and it is rare that the worker who digs out new truth 'at the face,' so to speak, is also responsible for bringing it to the surface for the public use, still less for distributing the new scientific apparatus or ideas broadly, and even less

for the profitable exploitation of the whole process. These functions are nearly always distinct, even though they are embraced under the one general popular description: chemist, engineer, etc. But in few cases is it any part of the professional training in the subject itself, to study how new products or processes affect the structure or welfare of society. I have questioned many scientific workers and find them, of course, keenly alive to the positive and direct beneficial effects of their work, but they have rarely any quantitative ideas as to negative, indirect and disturbing consequences. All these discoveries, these scientific infants, duly born and left on the doorstep of society, get taken in and variously cared for, but on no known principle, and with no directions from the progenitors. Nor do the economists usually acknowledge any duty to study this phase, to indicate any series of tests of their value to society, or even of methods and regulation of the optimum rate of introduction of novelty. These things just 'happen' generally under the urge of profit, and of consumers' desire, in free competition, regardless of the worthiness of new desire against old, or of the shifts of production and, therefore, employment, with their social consequences. The economist rightly studies these when they happen, but he is not dogmatic about them not being allowed to happen at all in just that way on account of the social disturbance or degradation of non-economic values which they may involve. It is surely a 'no-man's land' for it is rarely that the functions of government begin until a vested problem exists. Especially in Britain we do not anticipate—'Don't worry,—it may never happen.' Problems with us are usually called 'academic' until we are 'going down for the third time'. It is a maxim of political expediency not to look too far ahead, for it is declared that one will always provide for the wrong contingency. The national foresight over wireless was exceptional, and it has to be contrasted with the opportunist treatment of the internal combustion engine. In reply, it can, of course, be urged that no one can foresee just how a scientific idea will develop until it is tried out, rough and tumble, in economic society, and to make anticipatory rules may even hinder its development.

It is rightly stated that the training of the scientist includes no awareness of the social consequences of his work, and the training of the statesman and administrator no preparation for the potentiality of rapid scientific advance and drastic adjustment due to it, no provision of the technical forces which are shaping the society in which he lives. The crucial impact is nobody's business.

When the research worker lifts his attention from his immediate pursuit and contemplates its hinterland, he has three possible areas of thought. He may dwell upon its practical applications and seek to make them as immediate and realistic as possible; moved by the desire not to be merely academic, he may return to his task, to focus his attention primarily on what is likely to be of practical utility, rather than on what is intellectually intriguing. Or he may think of its ultimate social consequences, and speculate on the shifts in demand, the unemployment, the loss of capital, the ultimate raising of the standard of life that may result—in other words, he may engage in economic prevision and social and political planning for the results of his efforts. Or in the third place, he may listen and watch for hints from other fields of scientific study which may react upon his own, and suggest or solve his problems. I do not attempt to give these priority. Economic and political prevision is the most difficult and precarious, because it needs a technique different from his own, and is not given by the light of nature. Specialist scientists have no particular gifts for understanding the institutional processes of social life and the psychology of multiple and mass decisions. It is a tortuous and baffling art to transmute their exact findings into the wills and lives of unscientific millions. But quite a number engage in the pursuit and have not much greater aptitude as amateur ministers of foresight than statesmen would have in planning research. Fewer are skilled, however, in what should be the most appropriate auxiliary to their work—the synthesising of scientific knowledge. The more penetrating they are in their main pursuits, the less may they absorb through analogy or plain intimation from outside. We constantly hear that the average clinical application lags much farther behind the new resources of diagnosis from the laboratory than circumstances compel. But it may be the other way round. The strongest hint of the presence of a particular factor—a positive element in

beri-beri—was given by the clinician to the bio-chemist, who relied entirely on the *absence* of a particular factor, a negative element, no less than fifteen years before the bio-chemist took serious notice, looked for it, and found it. Bacteriology and chemistry await the advance of the bio-chemist before they come effectively to each other's assistance. The cause and prevention of the obstinate degree of maternal mortality are objects pursued *ad hoc*, with hardly a casual glance at the direct appeal of the eugenist to observe the natural consequences of an improvement in female infant mortality two decades earlier.

I do not then pretend to dogmatise as to how far the scientist should become a social reformer. One physicist welcomes the growing sense of social responsibility, among some scientists at least, for the world the labours of their order have so largely created, though he deplores that in this field they are still utterly unscientific. Then another great authority, Sir Henry Dale, declares that it is the scientists' job to develop their science without consideration of the social uses to which their work might be put.

I have long watched the processes by which the scientific specialist 'makes up his mind' in fields of enquiry outside his own. It seems still a matter for investigation whether the development of a specialist's thinking on balance impairs or improves the powers of general thinking compared with what they might otherwise have been. We do not know the kind or degree of truth that may rest in Anatole France's aphorism: 'The worst of science is, it stops you thinking.' Perhaps this was more subtly expressed in the simpler words of the darkie mother: 'If you haven't an education, you 've jest *got* to use yoh brains.'

My own experience is that when the attempt to deal with social consequences is made, we quickly find ourselves either in the field of larger politics debating the merits of the three prevalent forms of state government, or else performing miracles with fancy currencies and their blue prints reminiscent of the chemical engineer.

But there are some essential features of the impact which must be dealt with under any form of society and government and with any machinery for regulating values. They involve man's abilities, his affections and his tools, all of which have been brusquely treated in the past, and might be scientifically treated in the future. An industrial civilisation is unthinkable without division and, therefore, specialisation, of labour, and without tools and capital instruments. Then life itself is not much worth living without social ties and the allegiances of place and kin. These three indispensable elements of the good life bring out defensive mechanisms for their protection. No one likes to see a man highly trained for a special service or specially fitted by natural aptitudes cut off from opportunity to use his powers and reduced to the level of an unskilled biped. No one likes to see the results of abstinence and specially directed labour which is embodied in a great machine or factory rendered impotent long before it has given its life's usefulness. Waste of skill and of capital are alike grave faults by which we should judge and condemn an industrial organisation. And since man does not live by bread alone, if a ruthless industrial organisation continually tears up the family from its roots, transferring it without choice, to new surroundings, destroying the ties of kin, home and social life, of educational and recreational environments, it is far from ideal. Human labour can never be indefinitely fluid and transferable in a society that has a soul above consumption of mere commodities. These three obstructions to change are not final and rigid limitations upon it. Men die, their skill and home associations with them. Plant and equipment wear out. Their successor presents a natural opportunity in each of the three cases for the introduction of change in position, in aptitude, in purpose or design, without waste or human distress. The length of working life and the durability of materials mark the natural phase or periodicity of a smoothly changing society—its quanta, so to speak. But the impetus for change or the irritant has no such intervals. It proceeds from various causes: varying harvests, changes in natural forces; changing human desires and fashions; differences in the rate of growth of population in its different parts; the collective psychological errors of optimism and pessimism in business in an individualistic society; variations in gold supplies and credit policies based thereon. All or any of these, without

invoking any disturbances from the impact of scientific discovery, would serve to make adjustments necessary outside the natural phases to which I have referred, in a society with parts that are interdependent through division of labour, and localisation of industry, joined by foreign trade and convenient transport. These alone would bring about a changing world with incomplete adaptations, loss of capital, and so-called frictional unemployment. It is easy to exaggerate the adjustment necessary for the addition of invention and science to these causes of change. But with the intensification of scientific effort, and the greater subdivision of industry, the possible dislocation becomes more frequent and the ways of meeting such change of greater public importance. This field of inquiry includes widely diverse questions, *e.g.*, patent laws, invention clearing, obsolescence accountancy and costing regulation, taxation adjustments, local rating pooling, trade union regulations, price controls, technical education, age and other discriminations in unemployment relief, transfer bonuses, pension rights, housing facilities, and more selective direction of financial support of intensive scientific research. In this neutral field the specialist scientist and the politician are both amateurs. It is to be covered by each extending his studies, and by specialists who treat impact and change as an area of scientific study.

I do not propose to go over all the ground, so old, so constantly renewed, as to the effect of machinery upon employment. It is known as an historical induction that in the long run, it makes more employment than it destroys, in providing work in making the machinery, in reducing price so that far greater quantities of the commodity concerned may be consumed, and in enabling purchasing power to be diverted to increase other productions. It has even facilitated the creation of a larger population, which in turn has provided the new markets to work off the additional potentiality of the machinery. It does all this in 'the long run,' but man has to live in the short run, and at any given moment there may be such an aggregation of unadjusted 'short runs' as to amount to a real social hardship. Moreover, it comes in this generation to a people made self-conscious by statistical data repeated widespread at frequent intervals, and to a people socially much more sensitive to all individual hardship and vicissitude which is brought about by communal advance.

There are two important aspects of the change induced by science which are insufficiently realised, and which makes a profound difference to the direction of thought and inquiry. The first I will call the 'balance of innovation' and the second the 'safety valve' of population.

The changes brought by science in economic life may be broadly classified as the 'work creators' and the 'work savers'. The latter save time, work and money by enabling the existing supply of particular commodities to be produced more easily, and therefore at lower cost, and finally at lower prices. People can spend as much money as before upon them and get larger quantities or they can continue to buy their existing requirements at a lower cost. In this second event they 'save money' and their purchasing power is released for other purposes. By a parallel process, producing or labouring power is released through unemployment. The released working force and released purchasing power can come together again in an *increased* demand for other products which, to this extent, have not been hitherto within effective demand. The supply of this increase may go part or all of the way to absorb the displaced labour. But this process takes time, and the labour displaced is not at once of the right kind nor in the right place. More important, however, is the invention of quite new objects of public demand, which may be desired in addition to the supply of old ones. This brings together released labour and released purchasing power in the most decisive way. The most orderly and least disturbing phases of progress will be found when these two types of innovation are reasonably balanced. Of course, few new objects of purchasing ambition are entirely additive; most of them displace some other existing supplies. Artificial silk displaces some cotton consumption, radio may displace some types of musical instruments. Recently the German production of pianos and guitars has been at a very low percentage of capacity, and part of this has been made good by the demand for radio sets. The dislocations caused by labour-saving machinery can most easily be made

good by a due *balance* of new labour creating commodities.

A natural increase of population is the best shock absorber that the community can possess, especially if accompanied by an extension of territory such as the United States enjoyed in the constant westward movement of the frontier in the nineteenth century, or Britain in the period of overseas emigration. A moment's reflection will show why this is the case. Assume that 1,000,000 units of a commodity are made by 100,000 men, and that there is an increase of population of 2 per cent. per annum, so that in five years 1,100,000 units will be consumed and employ 110,000 men. Now assume the introduction of a new invention which enables 1,100,000 units to be made by 100,000 men. There will be no displacement of existing labour, but only a redirection of new and potential labour from that industry to other fields. Again, a considerable reduction in demand *per head* can be sustained without dislocation, if the actual aggregate of production demanded is maintained by increasing numbers. The affected industry can remain static and need not become derelict. New entrants to industry will be directed to those points where purchasing power, released through labour-saving devices, is creating new opportunity with new products. New capital is also naturally directed into the new channels, instead of into additions to the old industry.

Now the problem before all western industrial countries is the fact that their populations are shortly becoming stationary (and then will begin to decline noticeably) and this safety valve of increasing population will no longer be available. Every transfer of *per capita* purchasing power to new directions must then be a definite deduction from the old directions, no longer made good by the steady increase in the numbers demanding less per head from those old sources. The impact of science upon a stationary population is likely, *ceteris paribus*, to be much more severely felt than upon a growing population, because the changes of direction cannot be absorbed by the newly directed workers. Of course, the effects of a static population can be mitigated if the *per capita* income is increasing, because a new direction of demand can be satisfied out of the additional purchasing power without disturbing the original directions of demand provided by the original purchasing power. But the change from a growing to a static or declining population is only one type of difficulty. While the aggregate is altering but slowly, the parts may be changing rapidly. Thus, in this country 40·4 millions in 1937 becomes 40·6 in 1942, 40 in 1947, 39·8 millions in 1952, 38·9 in 1957 and 37·5 in 1962. But the children aged 16—which I take because of its influence on schools, teaching and industrial entry—have been estimated, taking those in 1937 as 100, to be 85 in 1942, 73 in 1952 and 62 in 1962. A fall of this magnitude means that industries and institutions dependent upon the present numbers must not be merely static but actually regressive. On the other hand, the old people from 65 to 74 will increase in this ratio—100, 113, 127 and 133. These problems of static populations at home are accentuated by the possibility of a similar tendency abroad, and need thought in advance. The Australian farmer is more affected by the British conditions of population than by his own.

We have thus the first difficulty, that of a static total demand, the second, that the safety valve of new industrial entrants is becoming smaller, but a third difficulty comes from the present tendency of that class. A stationary elderly population must be very inflexible to change, but a stream of new young life, even if it is to be smaller, would give the opportunity for just that change of direction, in training and mobility, which society needs. But unfortunately, in practice this does not now seem to be very adaptable. For we learn from certain Unemployment Insurance areas that while the older people will willingly take jobs at wages a few shillings in excess of the unemployment relief, the younger men are more difficult. For every one that will accept training under good conditions to suit them for eligible work, ten may refuse, and the number who will not go any distance to take work at good wages is also in excess of those who do. Attachment to place for older people is understandable, and has been accentuated by housing difficulties—one learns of miners unemployed in a village where the prospects of the pit reopening are negligible, while at the same time, only twenty miles away new miners are being created by attraction from agriculture to more extended workings in their area. The very social machinery which is set up to facilitate change or to

soften dislocation, aggravates the evil. The first two difficulties are unalterable. This third difficulty is a subject for scientific examination.

So much for the effect of change of any kind upon employment. Now let us narrow this to scientific changes. At any given moment the impact of science is always causing some unemployment, but at the same time the constructive additional employment following upon past expired impacts is being enjoyed. But it is easy to exaggerate the amount of the balance of net technological unemployment. For industrial disequilibrium arises in many ways, having nothing whatever to do with science. Changes of fashion, exhaustion of resources, differential growth in population, changing customs and tariffs, the psychological booms and depressions of trade through monetary and other causes, all disturb equilibrium, and therefore, contract and expand employment in particular places. Our analytical knowledge of unemployment is bringing home the fact that, like capital accumulation, it is the result of many forces. A recent official report indicated that a quite unexpected amount or percentage of unemployment would be present even in boom times. We know already that there may be a shortage of required labour in a district where there is an 8 or 10 per cent. figure of unemployment. So, in this country there may well be a million unemployed in what we should call good times—it is part of the price we pay for the high standard of life secured by those who retain employment. For a level of real wage may be high enough to prevent every one being employable at that wage—though that is by no means the whole economic story of unemployment. Of this number probably 200,000 would be practically unemployable on any ordinary basis—the 'hard core' as it is called. Perhaps seven or eight hundred thousand from the perpetual body, changing incessantly as to its unit composition, and consisting of workers undergoing transition from job to job, from place to place, from industry to industry, with seasonal occupations—the elements of 'frictional' unemployment through different causes. Out of this number, I should hazard that not more than 250,000 would be unemployed through the particular disturbing element of net scientific innovation. This is the maximum charge that should be laid at the door of science, except in special times, such as after a war, when the ordinary application of new scientific ideas day by day has been delayed, and all the postponed changes tend to come with a rush. At any given moment, of course, the technological unemployment that could be computed from the potentiality of new processes over displaced ones, appears to be much greater. But such figures are *gross*, and from them must be deducted all recent employment in producing new things or larger production of old things, due to science. If we are presenting science with part of the responsible account of frictional unemployment at any moment, it will be the total technological reduction due to new processes and displacement due to altered directions of demand, less the total new employment created by new objects of demand. This has to be remembered when we are being frightened by the new machine that does with one man what formerly engaged ten. Perhaps birth-control for people demands ultimately birth-control for their impedimenta.

The rate of introduction of new methods and the consequent impact upon employment may depend upon the size and character of the business unit. If all the producing plants for a particular market are under one control, or under a co-ordinated arrangement, the rate of introduction of a new labour-saving device will be governed by a simple consideration. It can be introduced with each renewal programme for each replacement of an obsolete unit, and therefore without waste of capital through premature obsolescence. But this applies only to small advantages. If the advantages are large, the difference in working costs for a given production between the old and the new types may be so considerable that it will meet not only all charges for the new capital but also amortize the wasted life of the assets displaced before they are worn out. In neither case then is there any waste of capital, and the absorption of the new idea is orderly in time. But it is quite otherwise if the units are in different ownerships. Excess capacity can quickly result from new ideas. A new ship or hotel or vehicle with the latest attractions of scientific invention, quite marginal in their character, may obtain the bulk of the custom, and render half empty and, therefore, half obsolete, a unit built only a year before. The old unit has to compete by lower prices, and make smaller profits. The newer unit is called upon to bear no

burdens in aid of the reduced capital values of the old. It may be that the enhanced profits of the one added to the reduced profits of the other make an average return upon capital not far different from the average that would result in a community where orderly introduction on a renewal basis is the rule. Or perhaps the community gets some of its novelties rather earlier under competitive conditions and pays a higher rate of interest for them as a net cover for the risks of obsolescence. Waste of capital would be at a minimum if the 'physical' life before wearing out were as short as the 'social' life of the machine. To make a thing so well that it will last 'for ever' is nothing to boast about if it will be out of fashion in a few years.

Scientists often look at the problem of practical application as if getting it as rapidly as possible were the only factor to be considered in social advantage, and this difference in the position of monopoly or single management in their ability to 'hold up' new ideas is treated as a frustration in itself. Thus it has been said 'the danger of obsolescence is a great preventative of fundamental applications to science. Large firms tend to be excessively rigid in the structures of production.' Supposing that the obsolescence in question is a real factor of cost, it would fall to be reckoned with in the computation for transition, whatever the form of society, and even if the personal 'profit' incentive were inoperative. It cannot be spirited away. A customary or compulsory loading of costs for short life obsolescence would retard uneconomically rapid competition of novelties and could be scientifically explored.

Now let us look at displaced labour and the costs of it. If the effect of diversion of demand through invention is to reduce the scope or output of particular industries or concerns in private management, they have no option but to reduce staff. If the pressure is not too great, or the change too rapid, this does not necessarily result in dismissals, for the contraction of numbers may be made by not filling up, with young people, the vacancies caused by natural wastage, through death and retirement. But where dismissals are inevitable, re-engagements may take place quickly in the competing industries, otherwise unemployment ensues. Any resulting burden does not fall upon the contracting and unprofitable industry—it has troubles enough of its own already. Nor is it put upon the new and rising industry, which is attracting to itself the transferred profits. In the abstract, it might be deemed proper that before the net gains of such an industry are computed or enjoyed it should bear the burdens of the social dislocation it causes by its intrusion into society. In practice, it would be difficult to assess its liability under this head, and in fact even if it could be determined, new industries have so many pioneer efforts and losses, so many failures, so many superseded beginnings, that it might well be bad social policy to put this burden upon them, for they would be dicouraged from starting at all, if they had to face the prospect of such an overhead cost whatever their results. It would, of course, be theoretically possible to put a special levy on those new industries that turned out to be profitable, and to use it to relieve the social charges of dislocation of labour. But much the same argument could be used for the relief of obsoletism of capital. The distinction would, however, be that in the case of the capital it could be urged that the investor should have been wide enough awake to see the possibilities of the rival, whereas the worker, induced to take up employment in such a superseded industry, was a victim, and could not be expected to avoid it by prevision. In any case, the prevailing sentiment is rather to encourage developing industries, than to put special burdens upon them, in order that the fruits of science may be effectively enjoyed by society with as little delay as possible.

In the upshot, therefore, the injuries to labour, though not to capital, are regarded as equitably a charge to be borne by society in general through taxation, and to be put upon neither the causing nor the suffering business unit.

And it may well be assumed that taken throughout, the gains of society as a whole from the rapid advance are ample enough to cover a charge for consequential damages. But society is not consciously doing anything to regulate the rate of change to an optimum point in the net balance between gain and damage.

The willingness of society to accept this burden is probably mainly due to the

difficulty of fairly placing it, for we find that when it *can* actually be isolated and the community happens fortuitously to have a control, or the workers a power to induce, it will be thrown, not upon the attacking industry, if I may so call it, but upon the defender. Thus in the United States recently, the price of consent to co-ordinating schemes made for the railroads to reduce operating expenses, has been an agreement on this very point. If staff is dismissed, as it was on a large scale in the depression, because of fewer operations and less stock in consequence of reduced carriage through the smaller volume of trade, or through road and sea competition, no attempt is made to put any of the social cost upon the railroads, and the dismissed staff become part of the general unemployed. But if the self-defence of the companies against competition takes the form of co-operation with each other to reduce operations and stock and, therefore, costs, any resultant dismissals are made a first charge upon them. The agreement is elaborate, and has the effect of preventing any adjustments which an ordinary business might readily make when it throws the burden on society, unless those adjustments yield a margin of advantage large enough to pay for their particular special effects. Thus the rapidity of adjustment to new conditions, not to meet the case of higher profits to be made at the expense of workers, but rather to obviate losses through new competition, is materially affected, and a brake is put upon the mechanism of equilibrium in this industry which does not exist in its rivals, or in any others where the power exists to throw it upon the community. A similar provision exists in the Argentine, and it is imposed by Act of Parliament in Canada, but as one of the concerns is nationally owned, and the current losses fall upon the national budget, its charge is really socially borne in the end. In this country such provisions were part of the amalgamation project of 1923, and of the formation of a single transport authority in London in 1933 and, therefore, did not arise through steps taken to meet new factors of competition. But the opportunity for their imposition came when rights to road powers and rights to pooling arrangements were sought by the railways —both of them adjusting mechanisms to minimise the losses due to the impact of new invention—and this was clearly a specialised case of keeping the burdens off the society. In the case of the electricity supply amalgamation of 1933, brought about for positive advantages rather than in defence against competition, similar provision was made, and parliamentary powers for transfers to gas and water undertakings, also not defensive against innovation, have been accompanied by this obligation. In the case of such uncontrolled businesses as Imperial Chemicals and Shell Mex, rationalising to secure greater profits, rather than fighting rearguard actions to prevent losses, obligations to deal with redundancies had been voluntarily assumed. In such cases the public obloquy of big business operations inimical to society can be a negative inducement, but some freedom from radical competition in prices provide a positive power to assume the burden initially, and pass it forward through price to consumers, rather than back against shareholders. The third case, however, of making it a net charge on the improved profits, is quite an adequate outlet. If the principle of putting this particular obstacle in the way of adjustments to meet new competition (as distinct from increasing profits) is socially and ethically correct, it is doubtful whether it is wisely confined to cases where there is quite fortuitously a strategic control by public will.

It will be clear that the difference between the introduction by purely competitive elements involving premature obsolescence and unemployment, and by delayed action, is a cost to society for a greater promptness of accessibility to novelty. The two elements of capital and labour put out of action, would have supplied society with an extra quantity of existing classes of goods, but society prefers to forego that for the privilege of an earlier anticipation of new things. I estimate this price to be of the order of three per cent. of the annual national income. But when we speak of social advantage on balance, outweighing social cost, we dare not be so simple in practice. If the aggregate individual advantage of adopting some novelty is $100x$ and the social cost in sustaining the consequential unemployed is $90x$, it does not follow that it is a justifiable bargain for society. The money cost is based on an economic minimum for important reasons of social repercussions. But the moral effects of unemployment upon the character and happiness of the individual

escape this equation altogether, and are so great that we must pause upon the figures. What shall it profit a civilisation if it gain the whole world of innovation and its victims lose their souls?

So far I have treated the problem of innovation as one of uneconomic rapidity. But there is another side—that of improvident tardiness. Enormous potentialities are seen by scientists waiting for adoption for human benefit, under a form of society quicker to realise their advantage, readier to raise the capital required, readier to pay any price for dislocation and to adjust the framework of society accordingly. A formidable list of these potentialities can be prepared and there is little doubt that with a mentality adjusted for change, society could advance much more rapidly. But there is a real distinction between the methods of adopting whatever it is decided to adopt, and the larger question of a more thoroughgoing adoption. In proportion as we can improve the impact of the present amount of innovation, we can face the problem of a larger amount or faster rate. Unless most scientific discoveries happen to come within the scope of the profit motive, and it is worth some one's while to supply them to the community, or unless the community can be made sufficiently scientifically minded to include this particular demand among their general commercial demands, or in substitution for others, nothing happens—the potential never becomes actual. It has been computed that a benevolent dictator could at a relatively small expense, by applying our modern knowledge of diet, add some two inches to the average stature and seven or eight pounds to the average weight of the general population, besides enormously increasing their resistance to disease. But dictators have disadvantages and most people prefer to govern their own lives indifferently, rather than to be ideal mammals under orders. To raise their own standard of scientific appreciation of facts is the better course, if it is not utopian. It has been clear for long enough that a diversion of part of the average family budget expenditure from alcohol to milk would be of great advantage. But it has not happened. If the individual realised the fact, it certainly might happen. It is ironically remarked that the giving of free milk to necessitous children, with all the net social gain that it may bring about, has not been a considered social action for its own sake, but only the by-product emergency of commercial pressure —not done at the instance of the Ministry of Health or the Board of Education, but to please the Milk Marketing Board by reducing the surplus stocks of milk in the interests of the producer!

Scientists see very clearly how, if politicians were more intelligent, if business men were more disinterested and had more social responsibility, if governments were more fearless, far-sighted, and flexible, our knowledge could be more fully and quickly used to the great advantage of the standard of life and health—the long lag could be avoided, and we should work for social ends. It means, says Mr. Julian Huxley, 'the replacement of the present socially irresponsible financial control by socially responsible planning bodies.' Also, it obviously involves very considerable alterations in the structure and objectives of society, and in the occupations and pre-occupations of its individuals. Now a careful study of the literature of planning shows that it deals mainly with planning the known, and hardly at all with planning for changes in the known. Although it contemplates 'planned' research, it does not generally provide for introducing the results of new research into the plan, and for dealing with the actual *impact*—the unemployment, redirection of skill, and location, and the breaking of sentimental ties that distinguish men from robots. It seems to have not many more expedients for this human problem than our quasi-individualist society with its alleged irresponsibility. It also tends to assume that we can tell in advance what will succeed in public demand and what will be superseded. There is nothing more difficult, and the attempt to judge correctly under the intellectual stimulus of high profits and risk of great losses is at least as likely to succeed as the less personally vital decision on a committee. Would a planning committee, for example, planning a new hotel in 1904, have known any better than capitalist prevision that the fifteen bathrooms then considered adequate for social demand, ought really to have been ten times that number if the hotel was not to be considered obsolete thirty years later? Prevision thought of in terms of hindsight is easy, and few scientists have enjoyed the responsibility of making practical decisions as to what the public will want far ahead. They, therefore, tend to think of prevision

in terms of knowledge and appreciation of particular scientific possibilities, whereas it involves unknown demand schedules, the unceasing baffling principle of substitution, the inertia of institutions, the crusts of tradition and the queer incalculability of mass mind. Of course, in a world where people go where they are told, when they are told, do what they are instructed to do, accept the reward they are allotted, consume what is provided for them, and what is manifestly so scientifically 'good for them' these difficulties need not arise. The human problem will then be the 'Impact of Planning'. I am not here examining the economics of planning as such, but only indicating that it does not provide automatically the secret of correct prevision in scientific innovation. When correct prevision is possible a committee can aim at planning with a minimum disturbance and wastage (and has the advantage over individuals acting competitively), but for such innovation as proves to be necessary it does not obviate the human disturbance or radically change its character. The parts of human life are co-ordinated and some are more capable of quick alteration than others, while all are mutually involved. One may consider the analogy of a railway system which has evolved, partly empirically and partly consciously, as a co-ordinated whole. Suddenly the customary speed is radically changed, and then it may be that all the factors are inappropriate—distance between signals, braking power, radius of curves, camber or super-elevation, angles of crossings, bridge stresses. The harmony has been destroyed. Especially may this be the case if the new factor applies to some units only, and not to all, when the potential density of traffic may be actually lessened. The analogy for the social system is obvious and its form of government matters little for the presence of the problem, though it may be important in the handling of it.

I have spoken as though the normal span of life of men and machinery themselves provides a phase to which scientific advance might be adjusted for a completely smooth social advance. But this would be to ignore customs and institutions, even as we see in Federal America, Australia and Canada, constitutions which lengthen that phase and make it less amenable as a natural transition. At one time we relied on these to bring about the economic adjustment necessary. But technical changes take place so rapidly that such forces work far too slowly to make the required adaptation. Habits and customs are too resistant to change in most national societies to bring about radical institutional changes with rapidity, and we patch with new institutions and rules to alleviate the effects rather than remove the causes of maladjustments. The twenty mile speed limit long outstayed its fitness, and old building restrictions remained to hamper progress. Edison is reported to have said that it takes twenty-five years to get an idea into the American mind. The Webbs have given me a model period of nineteen years from the time when an idea comes up as a practical proposition from a 'dangerous' left wing to the date when it is effectively enacted by the moderate or 'safe' progressive party. This period of political gestation may be a function of human psychology or of social structure. We do not know how ideas from a point of entry, permeate, infiltrate or saturate society, following the analogues of conduction, convection, or lines of magnetic force.

Our attitude of mind is still to regard change as the exceptional, and rest as the normal. This comes from centuries of tradition and experience, which have given us a tradition that each generation will substantially live amid the conditions governing the lives of its fathers, and transmit those conditions to the succeeding generation. As Whitehead says: 'we are living in the first period of human history for which this assumption is false.' As the time span of important change was considerably longer than that of a single human life, we enjoyed the illusion of fixed conditions. Now the time span is much shorter, and we must learn to experience change ourselves.

I have so far discussed modification of impact to meet the nature of man. Now we must consider modifying the nature of man to meet impact.

Sociologists refer to our 'cultural lags' when some of the phases of our social life change more quickly than others and thus get out of gear and cause maladjustments. Not sufficient harm is done to strike the imagination when the change is a slow one, and all the contexts of law, ethics, economic relations and educational ideals tend towards harmony and co-ordination. We can even tolerate by our conventions, gaps between

them when preachers and publicists can derive certain amusement and profit from pointing out our inconsistencies. But when things are moving very rapidly, these lags become important; the concepts of theology and ethics, the tradition of the law, all tend to lag seriously behind changes brought about through science, technical affairs and general economic life. Some hold that part of our present derangement is due to the lack of harmony between these different phases—the law and governmental forms constitutionally clearly lag behind even economic developments as impulsed by scientific discovery. An acute American observer has said that 'the causes of the greatest economic evils of to-day are to be found in the recent great multiplication of interferences by Government with the functioning of the markets, under the influence of antiquated doctrines growing out of conditions of far more primitive economic life.' It would be, perhaps, truer to say that we are becoming 'stability conscious' and setting greater store, on humanitarian grounds, by the evil effects of instability.

In the United States it would be difficult to find, except theoretically in the President, any actual person, or instrument in the Constitution, having any responsibility for looking at the picture of the country as a whole, and there is certainly none for making a co-ordinated plan. Indeed, in democracy, it is difficult to conceive it, because the man in public life is under continual pressure of particular groups, and so long as he has his electoral position to consider, he cannot put the general picture of progress in the forefront. Whitehead declared that when an adequate routine, the aim of every social system, is established, intelligence vanishes and the system is maintained by a co-ordination of conditioned reflexes. Specialised training alone is necessary. No one, from President to miner, need understand the system as a whole.

The price of pace is peace. Man must move by stages in which he enjoys for a space a settled idea, and thus there must always be something which is rather delayed in its introduction, and the source of sectional scientific scorn. If every day is 'moving' day, man must live in a constant muddle, and create that very fidget and unrest of mind which is the negation of happiness. Always 'jam to-morrow'—the to-morrow that 'never comes'. If we must have quanta on stages, the question is their optimum length and character, not merely the regulation of industry and innovation to their tempo, but the education of man and society to pulse in the same rhythmic wave-length or its harmonic.

In some ways we are so obsessed with the delight and advantage of discovery of new things that we have no proportionate regard for the problems of arrangement and absorption of the things discovered. We are like a contractor who has too many men bringing materials on to the site, and not enough men to erect the buildings with them. In other words, if a wise central direction were properly allocating research workers to the greatest marginal advantage, it would make some important transfers. There is not too much being devoted to research in physics and chemistry, as modifying industry, but there is too much relatively to the research upon the things they affect, in physiology, psychology, economics, sociology. We have not begun to secure an optimum balance. Additional financial resources should be applied more to the biological and human sciences than to the applied physical sciences, or possibly, if resources are limited, a transfer ought to be made from one to the other.

Apart from the superior tone sometimes adopted by 'pure science' towards its own applications, scientific snobbery extends to poor relations. Many of the hard-boiled experimental scientists in the older and so productive fields, look askance at the newer borderline sciences of genetics, eugenics and human heredity, psychology, education and sociology, the terrain of so much serious work but also the happy hunting ground of 'viewey' cranks and faddists. Here the academic soloist is still essential, and he has no great context of concerted work into which to fit his own. But unless progress is made in these fields which is comparable with the golden ages of discovery in physics and chemistry, we are producing progressively more problems for society than we are solving. A committee of population experts has recently found that the expenditure on the natural sciences is some eight to ten times greater than that on social sciences. There is hardly any money at all available for

their programme of research into the immense and vital problems of population in all its qualitative and quantitative bearings. An attack all along the front from politics and education to genetics and human heredity is long overdue. Leisure itself is an almost unexplored field scientifically. For we cannot depend wholly on a hit and miss process of personal adaptation, great though this may be. There must be optimal lines of change which are scientifically determinable. We have seen in a few years that the human or social temperament has a much wider range of tolerance than we had supposed. We can take several popular examples. The reaction to altered speed is prominent. In the *Creevey Papers*, it is recorded that the Knowsley party accomplished 23 miles per hour on the railway, and recorded it as 'frightful—impossible to divest yourself of the notion of instant death—it gave me a headache which has not left me yet—some damnable thing must come of it. I am glad to have seen this miracle, but quite satisfied with my first achievement being my last.' In the British Association meeting for 1836, an address on Railway Speeds prophesied that some day 50 miles an hour might be possible. Forty years ago, we may remember that a cyclist doing 15 to 18 miles an hour was a 'scorcher' and a public danger Twenty-five years ago, 30 miles an hour in motoring was an almost unhealthy and hardly bearable pace. To-day the fifties and sixties are easily borne, both by passenger and looker on. Aeroplane speeds are differently judged, but at any rate represent an extension of the tolerance. Direct taxation thirty years ago in relation to its effect on individual effort and action seemed to reach a breaking-point and was regarded as psychologically unbearable at levels which to-day are merely amusing. The copious protection of women's dress then would have looked upon to-day's rationality as suicidal lunacy. One hesitates to say, therefore, that resistances to scientific changes will be primarily in the difficulty of mental and physical adjustments. But there can be little doubt that with the right applications of experimental psychology and adjusted education, the mind of man would be still more adaptable. Unfortunately, we do not know whether education as an acquired characteristic is in any degree inheritable, and whether increasing educability of the mass is a mere dream, so that we are committed to a sisyphean task in each generation. Nor do we know whether this aspect is affected by the induced sterility of the age. It may not be a problem of changing the same man in his lifetime, but of making a larger difference between father and son. The latest teachings of geneticists hold out prospects for the future of man which we should like to find within our present grasp, and recent successful experiments with mammals in parthenogenesis and eutelegenesis bear some inscrutable expression which may be either the assurance of new hope for mankind or a devil's grin of decadence.

What is economics doing in this kaleidoscope ?

The body of doctrine which was a satisfactory analysis of society twenty-five years ago is no longer adequate, for its basic postulates are being rapidly changed. It confined itself then to the actual world it knew and did not elaborate theoretical systems on different bases which might never exist. It is, therefore, now engaged in profoundly modifying the old structures to meet these new conditions. Formerly it assumed, quite properly, a considerable degree of fluid or competitive adjustment in the response of factors of production to the stimulus or operation of price, which was really a theory of value-equilibrium. Wherever equilibrium was disturbed, the disturbance released forces tending to restore it. To-day many of the factors formerly free are relatively fixed, such as wage levels, prices, market quotas, and when an external impact at some point strikes the organism, instead of the effect being absorbed throughout the system by adjustments of all the parts, it now finds the shock evaded or transmitted by many of them, leaving the effects to be felt most severely at the few remaining points of free movement or accommodation. Unemployment is one of these. The extent to which this fact throws a breaking strain upon those remaining free points is not completely analysed, and the new economics of imperfect competition is not fully written out or absorbed. The delicate mechanism of price adjustment with the so-called law of supply and demand governed the whole movement, but with forcible fixation of certain price elements consequences arise in unexpected and remote quarters. Moreover, the search for a

communally planned system to secure freedom from maladjustments involves a new economics in which the central test of price must be superseded by a statistical mechanism and a calculus of costs which has not yet been satisfactorily worked out for a community retaining *some* freedom of individual action and choice. The old international currency equilibrated world forces and worked its way into internal conditions in order to do so. But the modern attempt to prevent any internal effect of changes in international trade, or to counteract them, and the choice of internal price stability at all costs against variable international economic equations, has set economic science a new structure to build out of old materials. At this moment when elasticity is most wanted, stability leading to rigidity becomes a fetish. The aftermath of war is the impossibility of organising society for peace.

The impact of economic science upon society to-day is intense and confusing, because, addressing itself to the logic of various sets of conditions as the likely or necessary ones according to its exponents, predilections, it speaks with several voices, and the public are bewildered. Unlike their claims upon physics and mathematics, since it is dealing with money, wages, and employment, the things of everyday, they have a natural feeling that it ought to be easily understandable and its truth recognisable. Balfour once said, in reference to Kant, 'Most people prefer a problem which they cannot explain, to an explanation which they cannot understand.' But in the past twenty years, the business world and the public have become economics-conscious, and dabble daily in index numbers of all kinds, and the paraphernalia of foreign exchange and statistics of economic life. The relativity of economic principle to national psychology baffles the economists themselves, for it can be said truly at one and the same time, for example, that confidence will be best secured by balancing the Budget, and by not balancing it, according to public mentality. The economics of a community not economically self-conscious are quite different from those of a people who watch every sign and act accordingly. Thus the common notion that economics should be judged by its ability to forecast (especially to a particular date) is quite fallacious, for the prophecy, if 'true' and believed, must destroy itself, inasmuch as the economic conduct involved in the forecast is different after the forecast from what it would have been before. The paradox is just here, for example: if a people are told that the peak of prices in a commodity will actually be on June 10, they will all so act that they anticipate the date and destroy it. Economics, thoroughly comprehended, can well foretell the effects of a tendency, but hardly ever the precise date or amount of critical events in those effects. The necessity for a concentration upon new theoretical and analytical analysis, and upon realistic research is very great. But so also is the need for widespread and popular teaching. For a single chemist or engineer may by his discovery affect the lives of millions who enter into it but do not understand it, whereas a conception in economic life however brilliant, generally requires the conformity of the understanding and wills of a great number before it can be effective.

But not alone economics: if the impact of science brings certain evils they can only be cured by more science. Ordered knowledge and principles are wanted at every point. Let us glance at three only, in widely different fields: man's work, man's health, man's moral responsibility. The initial impact of new science is in the factory itself. The kind of remedy required here is covered by the work of the National Institute of Industrial Psychology. Some of this improves upon past conditions, some creates the conditions of greater production, but much of it combats the evils arising from new conditions created by modern demands, speed, accuracy and intensity. It invokes the aid of many branches of science. It is the very first point of impact. Yet its finance is left to personal advocacy, and commands not 10 per cent. of the expenditure on research in artificial silk, without which the world was reasonably happy for some centuries. We can judge of the scope of this by the reports of the Industrial Health Research Board. Again, the scientific ancillaries of medicine have made immense strides. Clinical medicine as an art makes tardy, unscientific and halting use of them. The public remain as credulous as ever, their range of gullibility widened with every pseudo-scientific approach. (We do not know what proportion of positive cases can create the illusion of a significant majority in mass psychology, but I suspect that it is

often as low as twenty per cent.) For a considerable range of troubles inadequately represented in hospitals, the real experience passes through the hands of thousands of practitioners, each with too small a sample to be statistically significant, and is, therefore, wasted from a scientific standpoint. Half-verified theroies run riot as medical fashions, to peter out gradually in disillusionment. If the scattered cases were all-centralised through appropriately drawn case-histories, framed by a more scientifically trained profession, individual idiosyncrasy would cancel out, and mass scrutiny would bring the theories to a critical statistical issue of verification or refutation in a few months. This would be to the advantage of all society, and achieve an even greater boon in suggesting new points for central research.

A suggestion has been made for an inventions clearing house, to 'co-operate the scientific, social and industrial phases of Invention, and to reduce the lag between invention and application' managed by a committee of scientists and a committee of industrialists and bankers. The proposal came to me from New York, but London was to be the home of the organisation, which was to adopt a code of ethics in the interests of inventors, industry and *social progress*. This brings me to my third example, the field of ethics, which needs the toil of new thought. The systems of to-day, evolving over two thousand years, are rooted in individualism and the relations between individuals. But the relations of society to-day are not predominantly individual, for it is permeated through and through with corporate relations of every kind. Each of these works over some delegated area of the individual's choice of action, and evolves a separate code for the appropriate relationship. The assumption that ethical questions are decided by processes which engage the individual's whole ethical personality is no longer even remotely true. The joint-stock company may do something, or refrain from doing something, on behalf of its shareholders, which is a limited field of ethics, and may but faintly resemble what they would individually do with all other considerations added to their financial interests. The whole body of ethics needs to be reworked in the light of modern corporate relations, from Church and company, to cadet corps and the League of Nations.

In no case need we glorify change: but true rest may be only ideally controlled motion. The modern poet says:

> 'The endless cycle of idea and action,
> Endless invention, endless experiment,
> Brings knowledge of motion, but not of stillness.'

But so long as we are to have change—and it seems inevitable—let us master it. T. S. Eliot goes on:

> 'Where is the wisdom we have lost in knowledge?
> Where is the knowledge we have lost in information?'

My predecessors have spoken of the shortcomings of the active world—to me they are but the fallings short of science. Wherever we look we discover that if we are to avoid trouble we must take trouble—scientific trouble. The duality which puts science and man's other activity in contrasted categories with disharmony to be resolved, gaps to be bridged, is unreal. We are simply beholding ever-extending science too rough round the edges as it grows.

What we have learnt concerning the proper impact of science upon society in the past century is trifling, compared with what we have yet to discover and apply. We have spent much and long upon the science of matter, and the greater our success the greater must be our failure, unless we turn also at long last to an equal advance in the science of man.

Principles and Practice of Field Experimentation.*

A VERY useful publication by the well-known statistical experts Drs. Wishart and Sanders which will prove very helpful in clearing up many a difficulty with which the agricultural experimenter is confronted has recently appeared. The earlier statistical publications by the same publishers are now out of date, and the present one shows in a nutshell all recent improvements in field technique. Very few agricultural experimenters in India are in a position to understand critically Dr. Fisher's book *Statistical Methods for Research Workers*, though Dr. Fisher's methods of field technique are now being rigidly followed, in every farm in India and his ideas of *randomisation* and *replication*, and the mathematical concept of 'Analysis of Variance' have now become classical in the theory of field experimentation. Technical Communication No. 10 of Imperial Bureau of Soil Science—1930 (*The Arrangement of Field Experiments and the Statistical Reduction of the Results* by Fisher and Wishart) which is very popular now, clarified to a considerable extent most of Fisher's ideas, though the experimenter still felt that there were a few fundamental points on which the authors had not given a clear guidance to him.

Taking Part II first, of the publication under review, it attempts to answer most of the practical questions facing an experimenter. The authors have made however clear even at the outset, that Statistics is only a means to an end and that undue prominence should not be given to it in preference to botanical or chemical techniques which might require his greater attention. This is indeed a very useful warning, as in India too, there seems to be a tendency to exaggerate the usefulness of 'statistics' in field technique at the sacrifice of other important scientific considerations that should govern an experiment. But the part which 'statistics' plays cannot be denied both in the matter of the design of the experiment to answer specific problems, and in eventually reducing the results to a form from which valid conclusions could be deduced. The modern field technique, besides, is a considerable improvement over old methods, in that what are known as 'Complex Experiments' which involve a number of factors at a time such as several varieties and manures, are now becoming very popular.

The conduct of an experiment, if the data should be capable of satisfactory interpretation, involves a number of preliminary considerations which the authors have so lucidly set forth; firstly a suitable site for the experiment is a necessity; which should be *uniform* in surface soil, sub-soil and drainage, and with a history fairly known, which will be a guide for minimising the effects of patches in all possible ways. But such 'a uniform piece of land' is almost impossible, and the statistical device is to carry out a *uniformity trial* in the year or years previous to the experiment, and to correct the yield of a plot in the experimental year on the basis of the preliminary yield (by what is known as 'Covariance' method referred to again in a subsequent para). But unless the covariance or correlation between the preliminary and experimental yields in individual plots is high enough, which will lead to a large reduction of error, the *uniformity trial* loses its significance; and this is what has been found to be the case in experiments on *annual* crops where the correlation was found to be low. But in the case of perennial crops like 'tea', the method of covariance has yielded very valuable results.

The soil type of the farm should, of course, be representative of the country where the results of the experiment have to be applied in wider practice, and the experiment itself should include 'an established variety or method of cultivation' to act as the standard. Since the results of a single experiment are for one year only, it seems necessary before any practical recommendations are made with regard to their wider utility, that the experiment should be continued for at least three years to allow for weather sampling, and at as many centres as possible. Where such series of experiments are statistically combined for analysis (which would allow sufficient degrees of freedom for error), it should be noted that the *size and shape* of experimental plot should be kept constant, though the actual *randomisation* of plots should be done separately for each experiment.

The authors have rightly pointed out that a mere *significant* difference in the matter of yield is not sufficient to introduce

* *Principles and Practice of Field Experimentation.* By J. Wishart, M.A., D.Sc., and H. G. Sanders, M.A., Ph.D. (Empire Cotton Growing Corporation, King's Buildings, Dean Stanley Street, London, S.W. 1.) 1935. Pp. 100. Price 3/-, post free.

a new variety, for on one hand there is the question of economics, as even a 10 % increase may not be an economic advantage, and on the other hand there is the question of *quality*. There is however the difficulty of assessing the *quality* of crops, which as in the case of *pasture*, becomes complicated, as it depends both upon nutritive value and botanical composition. With cereals, *ability to stand* is an important consideration, as well as *earliness*. These are some of the points which should weigh with the experimenter before a definite variety is decided upon for extension. It seems therefore necessary from the point of view of deduction of proper results that *experimental plots* should also be accompanied by *observation plots*. The observation plots are generally used at the first stage of the enquiry for trying any number of new varieties, and eliminating as many as possible for the final experiment, but they serve much more useful purpose throughout the different stages of the enquiry, as large plots will be necessary to watch the *standing ability* of plants, their *tillering* capacity and effects of *spacing*, and so on. It is advisable to have such observation plots as close as possible to the experimental field.

Size, Shape and Arrangement of Experimental Plots.

Every experimenter knows that dealing with small plots, their *size*, *shape* and *arrangement* influence the standard error of the experiment. But so far, we in India have not definitely deduced what these should be for several crops grown under different conditions and for different types of experiment. These questions could however be solved only by special experiments designed for the purpose. But the authors have given some very useful tips which are worth noting. The uniformity trials in other countries show generally—these are corroborated by trials in India as well—that standard error goes down as the plot size increases to 1/40 acre, and that error goes up as we still further increase the size. But as a sufficient number of replications is necessary for ensuring validity for error, it is recommended that we may have even smaller plots than 1/40 acre, and increase the number of replications. Larger plots too could sometimes be preferred, if they could improve the convenience of agricultural operations.

With regard to plot-shape, the *square plot* has the advantage of minimising the edge effects (as in the case of cereals, lodging is a serious matter), while *oblong plots* may be helpful to take detailed growth observations by facilitating easy access to any part of the plot. In cultivation experiments it seems imperative to have long narrow plots, so also in the case of all experiments where plots should be separately drilled. Long narrow plots are, generally speaking, found to give lower standard error than square plots ; and it is particularly so in slopy areas with long sides of the plot running up the slope.

A further point which is of considerable moment to the experimenter is whether the Latin Square or randomised block arrangement should be preferred. Both the methods have advantages and disadvantages, and the type of experiment to be conducted seems to be the deciding factor in preferring the choice. While the Latin Square has the advantage of eliminating soil fertility in two directions, and is convenient for small dibbled plots, it has the disadvantage that the number of treatments or replications cannot exceed 7 or 8, as it will otherwise cover a large space and reduce the efficiency of the experiment ; nor can the treatments be less than 3 or 4 owing to the number of degrees of freedom being very small. One other point—which the authors have not touched—is that in the case of irrigation or manurial experiments the lateral seepage of water is a great disturbing factor, particularly so in the case of a Latin Square arrangement.

But with regard to 'randomised blocks design', its flexibility is its supreme merit ; there is no theoretical restriction to the number of treatments (though there should be a limit to the block size and hence to the number of treatments which should not normally exceed 10) ; and above all the randomised block method can be fitted even to an awkward-shaped field. For cultivation experiments, and drilling trials this method is admirably fitted, and the accessibility to each plot which the arrangement permits is indeed a great advantage. However, how far either method reduces the error has not been fully explored, and here the experimenter in India has ample scope for research.

But where the number of treatments is to be unduly large, what are known as 'confounded experiments' are now being adopted and the authors have not entered into a discussion of these very useful designs, except a reference to what are known as 'split-plot designs', which are now being largely used in India for irrigation and manurial experiments.

Pages 81–85 contain very useful points of advice to the experimenter. The number of replications to be adopted should be based from experience on the *standard error of the mean*; and for detecting *small* differences a larger number of replications will be necessary. Again it is wrong to adopt 'the same randomisation' for several experiments (instead of randomising each time), as it may introduce a bias; it is a mistake again to divide a plot into two or three and imagine that the replications are increased. Further, the process of 'randomisation' itself needs some definite procedure. Tippet's tables are now being largely used for picking random numbers, and if they are not available some convenient method of drawing—such as picking up cards—may be adopted. 'Randomisation' in the case of *Latin Square* is rather a cumbersome procedure, and it seems best to draw one of the types given by Yates (1933, *Empire J. Expt. Agri.*, i). Otherwise for the formation of Latin Square for use in field experiments, the rows may be picked up first with all the limitations of the Latin Square, and then the rows and columns may be randomised, amongst themselves.

SAMPLING TECHNIQUE.

This is probably the greatest difficulty facing the experimenter, and the authors have given a very clear guidance on the matter. 'Sampling of plants' merely means picking up a certain percentage of plants for observation, and such a selection is necessary where the population is very large. Developmental observations from stage to stage in the growth of the plant, such as its height, weight, etc., which would eventually explain the differences in yield, can best be done only by *sampling*; otherwise the process of counting and observation would become unnecessarily complicated. The sampling of plants from each plot should however be made free from *bias* and from different portions of the plot to be fairly representative of the plot. The usual sampling procedure is to divide the plot into sections, and to pick up by randomisation a few small areas (known as sampling units) from each section. With at least two sampling units in each unit, the sampling error is calculated as in the case of a split-plot design.

With p plots, 9 sections in each plot, and r sampling units in each section, the sampling error per unit-length will be based on $p\ 9\ (r-1)$ degrees of freedom; the sum of squares of 'between sections' in the several plots is first computed, and the difference between the total sum of squares and the sum computed already, will give the sum of squares for sampling, and this divided by $p\ 9\ (r-1)$ gives the sampling error per unit, from which the sampling error per plot can be calculated. The actual method of sampling—that is, the distribution of units over the plot—may be done in a number of ways, and here it is, a lot of useful work is possible to determine the best method of sampling on different crops under different conditions such as irrigated and unirrigated. The test for the efficacy for a particular method of sampling is that the sampling error should be low; where it is possible to compare the plot yields with the sample yields, the difference can be calculated, and for the efficacy of the sample, the correlation between the entire yield and the sample yield taken over all the sampling units should be high enough. Experience has shown that at least 5% of the plot yield should be sampled, and that the units should be scattered sufficiently well over the area. Another important point in connection with sampling is whether to take the *same units* at each observation; where it is possible to do so without damaging the plants as in the case of a bulky crop like sugarcane, the same set of plants may be maintained at each observation. In such a case, the *method of covariance* is particularly useful to correct error from stage to stage, and to correct for inequalities in plant number noted at the earlier counts.

Part I of this publication deals with the fundamental principles governing the modern experimentation in a very lucid way. The definition of 'experimental error', the influence of 'soil heterogeneity' in a field experiment, and what is known as 'significance' have all been explained to bring out their full meaning. The exact connotations of 'randomisation', 'replication' and 'local control' have been well illustrated from the layman's standpoint, and the principle of 'analysis of variance' has been well brought out by examples. The routine calculations leading to 'analysis of variance' have been popularised by easy steps. 'z' test and 't' test are a 'bug-bear' to the average experimenter, and from the examples given, these two tests have been well illustrated; and it has been shown that without 'z' test being satisfied, it is statistically unsound to proceed to further comparisons of treatments. The extension of 'analysis of variance' to complex experiments and to

splitplot designs, is logically one more step and the significance of different errors—*e.g.*, errors A and B—in the case of a split-plot design have been explained; it seems necessary to point out that the split-plot design cannot be used when all comparisons are wanted with *equal precision*.

The principle of 'covariance' so clearly explained in pages 45–56, is indeed a very powerful tool at the hands of the experimenter to clear many complicated points arising in the interpretation of data involving simultaneous variations. The method is particularly useful in correcting a set of data on the basis of preliminary observations, such as for example, yield of one year on the basis of yield of the previous year or years in the same set of plots; or again the yield may be corrected on the basis of plant or number. Similar to the usual analysis of variance, the table of analysis of covariance is constructed. It would be possible from such a table to know the correlations of 'within groups' or 'error', from which significant relationship or otherwise between the two sets of observations could be judged. The 'corrected' experimental yields are then worked out, which would form the correct basis for drawing inference. At Cambridge it has now become the habit to work out 'covariance' on all preliminary observations, and calculate r and b; if these are insignificant a further procedure becomes useless.

CONCLUSION.

The authors have thus covered practically almost the whole ground useful to the agricultural experimenter (except the principle of 'confounding' which is now being applied in a large measure to factorial designs), and have elucidated many points of interest. But it should be said that research suitable to our own conditions should be carried out to evolve our own standards in the matter of field technique.

M. VAIDYANATHAN.

Ancient Schistose Formations of Peninsular India*

THE most recent geological map of India appeared in 1931. No description of the geology of the country was published with the map; Sir Edwin Pascoe is now engaged in compiling such a description and this will appear at an early date as a *Manual of the Geology of India.* Some sixty per cent. of the area of the Peninsula is occupied by crystalline rocks and it is to be expected, perhaps, that these should receive a more detailed treatment than can be incorporated in a manual. It is such a treatment that Sir Lewis now contemplates.

There are two methods of attempting such a comprehensive work. One method is to write the whole and revise it immediately before submitting it to the Press; unfortunately, if the result is to be satisfactory, revision may mean the complete rewriting of the whole—a case in point is the *Geology of Australia* written by Sir Edgworth David and revised so thoroughly that it had not reached the Press up to the time of Sir Edgworth's lamentable death in 1934. The other method is to publish it piecemeal as the parts are written, with a final appendix in which may be summarised all that new material which accumulated during the successive appearance of the different parts. Presumably Sir Lewis intends to follow the latter plan.

The investigation of metamorphic rocks is a specialist's life study. Sir Lewis is such a specialist and his 17 years of field work included in 33 years of service in India renders him amongst those fitted to undertake such a work. Many geologists would prefer to see each section in a treatise of this nature from the pen of the authority or authorities in each particular area. Sir Lewis's plan of writing the whole himself at least eliminates the possibility of that acrimonious discussion which is so likely to appear from the clashing of the diverse views of authorities.

Those of us who have worked on metamorphic rocks and have also visited areas of metamorphic rocks in other countries will appreciate something of the task which

* "An attempt at the correlation of the ancient schistose formations of Peninsular India," by Sir Lewis Fermor, *Memoirs of the Geological Survey of India*, 1936, **70**, Part I, 51 pp. With one map.

Note: The memoir, part I of which is the subject of this review, is a comprehensive discussion on the Archæan rocks of India from the pen of Sir Lewis Fermor; the remaining parts are to appear from time to time during, it is hoped, the next few years.

Sir Lewis has set himself for India. In this country we have had detailed mapping in widely separated areas, and attempts at correlation may be compared, perhaps, to attempts at correlating the rocks of the Lake Superior region with metamorphic rocks in the Alleghanies, the Black Hills and in the Rockies, or between Scotland, Scandinavia and Central Europe. Unfortunately we are too prone to think of a country as a geological entity, forgetting the vastness of a country like India and the great distances separating the mapped areas. Except in a few isolated regions the geological map of India gives but a crude sketch of the Archæan rocks.

Detailed mapping on careful modern lines has been in progress for little more than 20 years; Sir Lewis makes the illuminating remark that "Most of our memoirs on the geology of Southern India were written before the introduction of the microscopic study of rocks into India." However, in Rajputana Dr. Heron's record of nearly 30 years of continuous mapping has resulted in the only satisfactorily completed areal unit in India. In other parts of India most of the work has been in progress continuously since the War. In the Central Provinces Sir Lewis Fermor's party has done some fine detailed mapping over a comparatively small area. In Bihar and the adjacent Eastern States Agency a party, centred around Singhbhum, has covered a rather larger area in detail. Recently a survey party commenced work in Bastar State which should clear up some of the problems of the Charnockites and related rocks. Geological surveys in South India have gone on continuously, but no connected account has appeared in recent years. These facts will indicate the real paucity of connection between these isolated areas.

Sir Lewis recognises all the difficulties and clearly enumerates them. One turns these first pages with something of awe for this brave attempt—there will be much of reverence if, on its conclusion, Sir Lewis has unrolled before us a convincing picture of any detailed correlation which he may make.

Part I is introductory in nature, its principal object being to discuss the several factors which may be concerned in correlation and to divide the country into provinces of a size suitable for description. One may note, at the commencement, that the memoir's title is not perhaps correct seeing that the author intends to describe rocks beyond the Peninsula—in Ceylon, Burma and the Himalayas.

On page 5, Sir Lewis re-quotes his definition of the term Archæan made in 1909; the arguments surrounding the use of the term *eparchæan unconformity* form nothing more nor less than a vicious circle. Cut down to the root of the matter the true definition is found on page 14—"I have taken the presence of either granitic or pegmatitic intrusives as sufficient reason for referring the rocks into which they are intruded to the Archæan rather than the Puranas."

In the excellent discussion of the well-known factors involved in correlation Sir Lewis brings up again the question of crush-conglomerates. I think, from their recent work, several Mysore geologists will demur at the statement: "In the Dharwar series of Mysore there are many conglomerates, but these are all regarded by the Mysore geologists as probably due to crush." Except in Sir Lewis's own area, Central Provinces, this mode of origin for sheared conglomerates seems to have died leaving no regrets.

Apparently the author intends to make some use of the manganese occurrences in correlation. This is dangerous ground of which, no doubt, he is well aware. In the Iron-ore series there is a manganiferous shale horizon near the base and another near the top. Similarly in the use of the iron-ore for the same purpose, although the Iron-ore series is the main source of iron-ores, the pebbles in the basal conglomerate indicate that iron-ores occurred in an older series.

There are several minor points with which some petrologists will not agree, such as metasomatism as an occasional factor in metamorphism, and the solvent action of water in metamorphism, but until we come to the discussion on charnockites there is nothing to cause serious disagreement from the point of view of the purpose of this memoir. Sir Lewis appears to have accepted Stillwell's view that the charnockites are metamorphic rocks of the hypo-zone. Many of us were of this view until recently, but some of us would now revert, in part, to Holland's original description of them as normal igneous rocks. May they not be

rocks formed by the crystallisation of a dry magma at great depth? In discussing, on page 50, why the Cuddapahs never come in contact with the charnockites Sir Lewis gives two reasons. I suggest to him a third: the charnockites were intruded at such great depths that they were nowhere exposed at the surface up to the time of deposition of the Cuddapahs.

For the infra-plutonic zone the author has made a good case and many of us will agree to the probability of his eclogite shell. Its suggested influence in the causation of earthquakes is unconvincing.

Finally, Sir Lewis explains the manner in which he has divided India (unfortunately he heads his table 'Peninsular India') into regions and provinces for purposes of description. The three regions: Non-charnockitic, charnockitic and "extra-Peninsular provinces" give an unbalanced division so far as area is concerned, and especially so when we note that probably 95 per cent. of the work to date has been done in the non-charnockite region. From the metamorphic point of view it is not a petrological division and gives neither a picture of facies nor of grade. It is simply a convenient description of areas, the charnockitic region covering merely the southernmost tip of the Peninsula and the east coast, the non-charnockitic being the rest of the Peninsula.

The eighteen subdivisions, or provinces, are on an areal basis but they are grouped into types some of which are, at least in name, lithological: in the non-charnockitic region there are the iron-ore provinces, the (manganese-ore)-marble provinces and the igneous provinces; in the charnockitic region there are the iron-ore provinces, (manganese-ore)-marble provinces and the garnetiferous provinces; the extra-Peninsular provinces are grouped (naturally) into the Himalayan and Burma occurrences. The grouping contains elements of lithological types, elements of facies and elements of areal distribution—a real hotch potch! Several of the groups contain common characteristics. It might just as well have been left entirely areal. However, classifications of this nature are entirely for clarity in description, and I would not advise the reader to give to it, at this stage, any other significance.

In conclusion I would suggest that as an appendix to the final part of the memoir the authorities on the different areas should be invited by Sir Lewis to express their opinions on his description of their respective areas and of his correlation, and so provide a completely balanced picture.

Correlations are undertaken by two types of people: those who are young and eager (I was rash enough to attempt one such some years ago) and those who, as they retire and leave the field to younger men, wish to leave behind them the fruits of their experience. Sir Lewis Fermor has left India, we wish him a long retirement and hope that he finds the time to put the finishing touches to his correlation.

J. A. DUNN.

A Nutritional Survey of the Poorer Classes in Ceylon.*

Dr. Nicholls gives a brief description of the various races inhabiting Ceylon; the three chief racial groups are the Sinhalese, Tamils and Moors. Education in Ceylon is compulsory and there are more than 3,000 schools and colleges. 12,737 boys and girls, aged 5–18 and belonging to various races and of various social origins, were weighed and measured. It was found that the height and weights means of children of the well-to-do classes were higher at all ages than those of the middle and poorest classes, those of the poorest classes being the lowest. Averages in the various social classes were much the same in each racial group, and it may probably be assumed that the most important factor affecting development is diet. Investigation showed that the diet of children of the poorer classes in the vernacular schools is very deficient in quality.

A diet survey of 15 peasant families was carried out, intake of calories and proximate principles worked out as follows :—

* By Lucius Nicholls, M.D., B.C., B.A., *Ceylon Journal of Science*, Vol. IV., Part I (April 21, 1936).

Protein (g)	Fat (g)	Carbohydrate (g)	Calories
55·5	32·0	365	1,942

The author suggests that "a diet of the value of about 2,200 calories is sufficient for the requirements of an agricultural labourer belonging to the smaller races of the tropics, provided the diet is well-balanced in necessary constituents."

Infantile mortality is high in Ceylon (176 per mille during the decade 1923–33). Among the most important causes of death are those entered in the returns as "debility" and "convulsions"; in the author's opinion, malnutrition is the basic cause of the majority of deaths entered under these heads. A large number of infantile deaths from a condition called "mandama" are registered; "mandama" is characterised by a papillar skin eruption, weakness of the limbs, and extreme wasting. Many patients with "mandama" have "sore-mouth", a condition now recognised to be due to diet deficiency, and eye signs and symptoms including xerophthalmia and keratomalacia. Dental carries and irregularities of the teeth were found to be more common in poor than in well-to-do children, and it seems probable that the high incidence of dental defects in the former is due to malnutrition.

The author discusses the relation between the recent malaria epidemic and nutrition. The epidemic was preceded by a drought, and after a partial failure of the rains of the north-east monsoon, drought conditions continued during the greater part of the epidemic period. The conclusion seems to be that "even if the masses had been well fed and prosperous, there would have been an epidemic of malaria, but the vicious circle of malaria and destitution acting and reacting on one another would not have been established, and the mortality rate would have been lower. Convalescence would have been shorter, and probably the infectivity and relapse rates would have been less."

Hookworm is common in Ceylon. It is estimated that 90 per cent. of the lower classes in Ceylon are harbouring on an average about 90 hookworms, which will withdraw about 9 c.c. of blood daily from the host. The presence of hookworm in the intestine must increase diet requirements, particularly in respect of iron and first class protein, to make good the steady loss due to withdrawal of blood.

Dr. Nicholls' survey should be closely studied in India, for nutritional conditions in Ceylon do not greatly differ from those existing in many parts of India. Preliminary surveys have shown that the various food deficiency diseases occurring in Ceylon are also, as might be expected, common in South India.

The Ceylon survey re-emphasises the paramount importance of nutrition in relation to public health in the East.

W. R. A.

CENTENARIES.

S. R. Ranganathan, M.A., L.T., F.L.S.

Fahrenheit, Gabriel Daniel (1686-1736).

FAHRENHEIT, the German Physicist, was born at Danzig on May 14, 1686. Having received his early education at Amsterdam, he travelled widely in England, Denmark and Sweden. His business was the manufacture of meteorological instruments; but he became deeply interested in physics, as a result of his close association with Olaf Romer, whom he probably visited in Copenhagen during 1709.

MERCURY THERMOMETER.

"Finding, in the history of the Royal Academy of Sciences, that M. Amontons had, by means of a thermometer of his own invention, discovered that water boils with a fixed degree of heat," Fahrenheit "was very desirous of making such another thermometer, to view with his own eyes this curious phenomenon of nature, and be convinced of the truth of the experiment. And recollecting what sagacious inquirers into nature had

written.... he imagined, that perhaps a thermometer might be made of mercury. Having made such a thermometer, though still imperfect in several respects, the event answered his expectation, to his no small satisfaction." He invented a successful method for cleaning mercury and was the first to bring about the general use of mercury in thermometers. With the aid of his thermometer, he made a series of tests on liquids other than water and found that each had a fixed boiling point.

FAHRENHEIT SCALE.

First he worked with thermometers filled with spirit of wine. He took two fixed points. "The first, the lowest.... is found by a mixture of ice, water and sal-ammoniac or sea-water; if the thermometer is dipped in this mixture, then the liquid falls to the point marked 0. This experiment succeeds better in winter than in summer." "The second is that point to which the alcohol expands if the thermometer be held in the mouth or armpit of a healthy person." He divided the interval first into 180 equal parts and later, into 96 parts. In 1724 he introduced a third point which corresponds to a mixture of ice and water alone. Later when he began to use mercury, he took, in the place of the temperature of the human body, the boiling point of water. On his scale, this happened to be at 212.

HONOURS.

Fahrenheit attained considerable celebrity by his investigation. In 1724 he was elected a Fellow of the Royal Society of London and contributed five short papers to the *Philosophical Transactions* of the Society. These papers have been reprinted in Heft 57 of Ostwald's *Klassiker*. One of these papers deals with a new form of hygrometer. He died in Holland on September 16, 1736.

* * *

Pond, John (1766-1836).

JOHN POND, English astronomer royal, was born about 1767 in London. His early education was at Maidstone Grammar School, under the tuition of Wales, astronomer to Captain Cook's expedition. His University course was at Trinity College, Cambridge. Due to ill health, which attended him almost through life, he spent several years abroad.

ENTERS ROYAL OBSERVATORY.

Pond's attention was directed to astronomy by Wales. Even when a boy, he detected some imperfection in the Greenwich instruments. Later in life, in the first decade of the nineteenth century, he got an altitude and azimuth circle of Troughton and undertook a series of observations from which he deduced that the quadrant then in use at Greenwich for the determination of declinations had changed its form since the time of Bradley. This brought his name to prominent notice among astronomers and led to his appointment as the head of the Royal Observatory. He soon gave up the quadrant and established a mural circle. "Mr. Pond saw, almost intuitively, the vast superiority of this over every other form of the declination instrument."

HIS CONTRIBUTIONS.

While at Cambridge, he missed the opportunity of acquiring that depth of mathematical knowledge which is necessary for the highest branches of theoretical astronomy. Hence, he devoted his official life mostly to observations and particularly to the determination of the places of fixed stars. Under Pond the instrumental equipment at Greenwich was completely changed. He published eight folio volumes of *Greenwich Observations*, translated Laplace's *Systeme du mon de* and contributed thirty-one learned papers. His catalogue of 1,112 stars, published in 1833, had great value.

HONOURS.

Pond was elected to the Royal Society in 1807 and was appointed Astronomer Royal in 1811. He received many academic honours. As a mere handler of instruments, Mr. Troughton, one of the best critics in such a matter, used to say that Mr. Pond had, within his knowledge, no equal or rival except Captain Kater. The testimony of the Astronomical Society is even greater. "It is not too much to say that meredian sidereal observation (which excludes the Herschalian branch of astronomy) owes more to him than to all his countrymen put together since the time of Bradley."

He retired in 1835 and died at Blackheath on September 7, 1836, and was buried beside Halley in the churchyard at Lee.

Villari, Emilio (1836-1904).

PROF. VILLARI of Naples was born in 1836. From his birth, he suffered from epilepsy. Having taken a degree in medicine at Pisa, he served, for a year, as a teacher in a medical school at Naples. He became the Professor of Physics at Pisa, in 1861. In 1864 he went to Berlin for higher studies in the laboratory of Magnus. From 1865 to 1871, he was Professor at Florence and from 1872 to 1889 he taught at Bologna. In the latter year, he became the Head of the Department of Physics at Naples.

X'D AIR.

His chief field of work was in the sphere of radioactivity. His investigations of the properties of "X'd air", *i.e.*, air and gases which have been rendered radioactive by Rontgen rays, are the most noteworthy. He published more than fifty papers in the organs of different learned societies. He was President of the Lincei Academy and an honorary member of the Physical Society of London and of the Royal Institution of Great Britain.

While he was Professor at Naples, his duties involved the conducting of three separate University courses of lectures, in the session of 1902–03. As a result of this, combined with research, he broke down under the stress of work and after a long and painful illness, he died on August 20, 1904.

* * *

Jussieu, Antoine Laurent De (1748-1836).

A. L. DE JUSSIEU, French systematic botanist, was born on April 12, 1748. He was the fourth of a French family which distinguished itself in botany during successive generations from the beginning of the eighteenth century to the middle of the nineteenth. The first of the line was Antoine, eldest uncle of the subject of this note, and he was born in 1686. The last was Adrien Laurent Henri, the son of Antoine Laurent, and he died in 1853.

Born at Lyons and educated at Paris for the medical profession A. L. De Jussieu, came under the influence of his uncle, Bernard, who possessed a profound knowledge of plants. In 1770, he became demonstrator in botany in the Jardin du Roi. This obliged him to occupy himself incessantly with acquiring a correct practical acquaintance with plants.

HIS CLASSIFICATION.

At that time the collection of plants in the Jardin du Roi was arranged according to the method of Tournefort; but shortly afterwards it became necessary to rearrange it. Of this opportunity Jussieu took advantage; he drew up a memoir upon a new method of arrangement which was read before the Academy of Sciences and afterwards carried into effect in the Garden. It is here that is found the first distinct trace of those clear ideas concerning the relative importance and subordination of characters which the author subsequently applied to the whole vegetable kingdom.

From this time, that is, from 1774 to 1789, Jussieu was constantly occupied in demonstrating to his class of botany, and as his new method was thus brought perpetually before him, with all its advantages and disadvantages, in practice, he was able to alter and improve it from year to year. This continuous ripe experience found its expression eventually in the famous book *Genera plantarum* (1789), which became the basis of modern classification.

HIS MEMOIRS.

In 1793, Jussieu became Professor of Rural Botany and later became Director and Treasurer of the Museum of Natural History. After an interval of political distractions necessitated by the Revolution, he recommenced, in 1802, his botanical writings, chiefly in the form of memoirs upon his own natural orders of plants. These, which were nearly sixty in number, appeared regularly in the *Annales du Museum* till 1820, after which time his failing eyesight prevented further work.

HIS LAST DAYS.

Nevertheless, he employed himself between his eighty-third and eighty-eighth year in dictating a new edition of his *Introduction in historian plantarum*. This work has been published since his death; it is written in elegant Latin and is a remarkable proof of the vigour of his intellect even at this advanced age. He appears to have been much loved by his family and greatly respected by his friends. He died after a short illness on the 15th September 1836, and left behind him a son, Adrien, his successor in the Chair of Botany and the author of *Botanique* which reached nine editions and was translated into many languages.

ASTRONOMICAL NOTES.

1. **Comet Notes.**—Comet 1936 *a* (Peltier) which attained naked eye visibility about the end of July, has been widely observed. Although weather conditions were generally unfavourable the Comet appears to have been seen by a few observers in India when it was near its maximum brightness. Several computers have calculated orbits for the comet from the observed positions in May and June, but the period cannot be predicted with certainty on account of the divergence from parabolic motion being very small. A more accurate determination will be possible when all the observations during this apparition, including those from the southern hemisphere, are used in the discussion.

The second new Comet of the year (1936 *b*) was discovered on July 17th by Mr. Kaho, a Japanese astronomer. At the time of discovery it was at its brightest—about the sixth magnitude and just visible to the naked eye.

2. **The Solar Eclipse of June 19, 1936.**—From the available information, it appears the weather was fairly good at many of the stations occupied by observers on the line of totality, although one of the British expeditions (under the leadership of Prof. Stratton) met with unfavourable weather at Hokkaido (Japan). Brief statements from some of the parties have been published, which indicate that the Corona was very bright and a type intermediate between maximum and minimum. Five brilliant prominences, it is stated, were seen during the total eclipse, and coronal arch structure was visible above one of the largest prominences. It will be some time before the detailed results are available from the several parties of astronomers who observed the eclipse.

3. **The Rings of Saturn.**—The earth passed very near the plane of Saturn's rings on June 28, 1936. Observing with the 36″ refractor of the Lick Observatory, J. H. Moore reports that the rings did not disappear entirely, but were clearly visible, about that time, as a fine bright line to the east and west of the planet.

4. **New Stars.**—Both *Nova Herculis* and *Nova Lacertæ* are easily visible at present with binoculars and small telescopes. *Nova Lacertæ* is declining rapidly, its magnitude being 8·4 on September 9. From spectroscopic observations its behaviour is found to be in general, like other novæ, but the absorption lines show remarkably large displacements. Merrill and Wilson have measured the intensities of detached lines in the spectrum of the Nova and have estimated its distance to be about 800 parsecs.

5. **Mass Ratios of Sirius and τ Cygni.**—Prof. Van de Kamp has made a new determination (*Astronomical Journal*, 1049) of the mass ratios of these two important binary stars from measures on a long series of photographs taken for parallax work at the Leander McCormick Observatory. In the case of Sirius the masses obtained are 2·6 for the bright star and 1·3 for the companion (taking the mass of the Sun as unity) while for the components of τ Cygni the masses are 2·4 and 0·8 respectively.

T. P. B.

OBITUARY.

Lieut.-Col. R. Knowles, C.I.E., I.M.S.

WE regret to have to announce the death of Lieut.-Col. R. Knowles, C.I.E., I.M.S., which occurred in the early hours of the morning of August 3rd at the Carmichael Hospital for Tropical Diseases, Calcutta.

Robert Knowles was born on October 30th, 1883, in India where his father was a missionary. His early education was at Mill Hill School. He went up to Cambridge (Downing) in 1901; here he took his arts degree and commenced his medical studies. From there he went to St. Mary's Hospital, London, and in 1907 took his qualifying diploma, the M.R.C.S., L.R.C.P. It was at St. Mary's Hospital where he worked under Sir Almroth Wright that Knowles first acquired a taste for medical research which was to be the dominating influence of his whole life. He took the I.M.S. entrance examination in 1908 and passed into the service at the top of his batch. After four years of military service he achieved his first ambition, and was put into the then-newly-formed Bacteriological Department which afterwards became the Medical Research Department.

He was posted as Assistant Director at the Pasteur Institute, Kasauli. Here he came in contact with a number of people who had a considerable influence on his life and work—Harvey, McKendrick and above all Acton. His first work was carried out with Acton as his collaborator and together these two workers published some important papers on the action of snake venom, on halteridium in pigeons and on other subjects; the first volume of the *Indian Journal of Medical Research* contains eight papers by them. Knowles always maintained his interest in snakes and snake venom, although he had little chance of doing further work on the subject, and the work on halteridium gave him an introduction to protozoology, a subject of which he later became a master.

His work at Kasauli was interrupted by the War, and he was sent to Mesopotamia with the 11th Mahratta Light Infantry. He was wounded very badly in the leg in the battle of Ctesiphon and was mentioned in dispatches, and after a long stay in hospital in India and later in London he was posted as Bacteriologist to Cumballa War Hospital in Bombay. As his leg wound had incapacitated him for active field service he was later transferred back to civil employment and was sent to Shillong to open the Pasteur Institute there. This was Knowles' first independent responsible post and he made a very great success out of it. The anti-rabic treatment was only a small part of the functions of the Institute. It was practically the only laboratory in the province and it had to be organised to deal with an enormous amount of routine laboratory work. And this was not all; at that time kala-azar was beginning to increase alarmingly in Assam and Knowles established a kala-azar ward and carried out an investigation on the treatment and on many other aspects of the disease. He worked out a scheme of dosage with sodium antimony tartrate—a drug that Sir Leonard Rogers had just introduced; this scheme was followed for many years in Assam until the new pentavalent compounds came into general use.

It was during this time at Shillong that Knowles met Sir Leonard Rogers; it had been at the latter's suggestion that he started the work on kala-azar. When Sir Leonard left India in 1920 he selected Knowles as his successor at the Medical College. He also left him the far more arduous task of starting the School of Tropical Medicine. Knowles decided to devote the whole of his energies to the latter task; he was appointed Secretary of the School and with the aid of Colonel Baptist (then Captain) organised the staffing and equipment of this large and important institution. The next year when the School opened he was appointed Professor of Protozoology, and he held this appointment until his death nearly sixteen years later.

He was determined that his classes in protozoology should be a success and he devoted an enormous amount of time and trouble not only in preparing his lecture notes but in collecting material from all over the world for demonstration specimens and for issuing to the practical classes. In 1923 he published his lecture notes in the form of a book which the students of the earlier years at the School found invaluable.

This would have been full-time occupation for most men but Knowles with his unbounded energy found time to carry out

many important research investigations. He maintained his interest in kala-azar and actively co-operated in the research that was being carried out on the transmission of this disease. The paper that he wrote with L. E. Napier and R. O. A. Smith on the development of leishmania in the sandfly, *Phlebotomus argentipes*, opened a new phase in the investigation of this subject. It would be out of the question here to attempt to enumerate the various investigations which he carried out in the realm of medical protozoology; his published papers covered a wide field, reporting investigations on trypanosomes, leishmania, spirochætes, amœbæ, intestinal flagellates, and human and simian plasmodia. During his last years he carried out some very important investigations on monkey plasmodium, a strain of which, first discovered at the Calcutta School by some of his associates and distinguished from other simian plasmodia by Sinton, was named after him, *Plasmodium knowlesi*. He and his valued assistant Biraj Mohun Das Gupta were the first to transmit this plasmodium to man. This strain has recently been used in the treatment of neurosyphilis in Europe.

Perhaps, Knowles will be best known for his excellent book on medical protozoology. For many years there was no satisfactory book on this subject for the student and it was always Knowles' ambition to provide one. In the first few years at the School he felt that there were too many gaps in our knowledge to make a book on the subject worth while; he thought that it would be out of date before it was printed. However, at the beginning of 1927 he felt that the time had come to put his notes together and to fill in the gaps, and by the end of the year he had completed the manuscript for his book which he modestly called an *Introduction to Medical Protozoology*. When he had written more than half the book, Wenyon's classical work on this subject came out and Knowles wavered in his intention, but he considered that Wenyon's book did not quite meet the needs of the Indian student and he decided to finish his own book. The new matter which Wenyon's book presented made it necessary for him to expand and even re-write some of the sections that were already finished. The writing of this book was a gigantic task which he completed in an incredibly short time.

Other important books that he wrote were *On the Dysenteries of India* with Acton and on malaria with Mr. S. White.

On a number of occasions he officiated as Director of the Calcutta School of Tropical Medicine.

He was Assistant Editor of the *Indian Medical Gazette* from 1922 to 1928 and Editor from 1928 to 1932; he devoted a very great deal of his time to editorial work and he did much to raise and to maintain the standard of this journal. He was a most facile and lucid writer, and his output was enormous.

During the last few years of his life ill health curtailed his activities; however even then he was not content just to do his routine duties and in 1934 he undertook the task of writing a comprehensive review of the work of the School of Tropical Medicine during the previous twelve years.

He was President of the Medical Section of the Science Congress in 1930 and his presidential address on the evolution of medical protozoology was an excellent example of Knowles' best work; it has frequently been quoted in this and other countries. He was always a great supporter of the Asiatic Society and he was for a long time Medical Secretary, and later for a number of years a Vice-President of the Society.

He was a Foundation Fellow and was also on the Council of the National Institute of Sciences of India.

He was given a C.I.E. in 1935, an honour which many of his friends considered he should have earned many years earlier.

The medical profession and medical research in particular have suffered a great loss through his untimely death.

L. E. NAPIER.

Scientists and War.

"THERE are three lusts which are present in the subconscious mind of man which lie at the basis of war, the lust of *power*, the lust of *prestige*, and the lust of *possession*." These remarks were made by Dr. Gilbert J. Fowler in the course of his presidential address at a discussion on "Moral responsibility of scientists in modern warfare," held at Bangalore on 22nd August, under the joint auspices of the Society of Biological Chemists, India, and the Institute of Chemistry. Sir Martin Forster, Mr. Ernest Kirk, Rao Bahadur Prof. B. Venkatesachar and Prof. C. R. Narayan Rao took part in the discussion.

In the course of a thoughtful address, Dr. Fowler observed, "My scientific and professional work has brought me in contact with chemists and engineers all over the world including Moscow and Japan. I may, therefore, claim to be something of a citizen of the world and can have no desire to hate or destroy the many good friends I have made.

My experience will, in some degree no doubt, be that of many other scientists and therefore, the scientist is pre-eminently fitted to be a friend of all the world.

If, however, this worthy ambition is to be realised, it would seem necessary that certain commonly voiced statements and their implications should first be criticised.

One view which is gaining ground is that the discoveries of scientists are themselves largely the cause of war. The fallacy of this will be evident after a moment's thinking.

It is often apparently assumed that poison gas or chemical warfare is due to the secret and develish investigations of chemists. Actually I believe practically all the gaseous weapons, used in the war, had been discovered previously in the course of purely peaceful investigations.

Another statement constantly made is that war is *inevitable*. This is to mistake the fundamental causation of things. Guns do not attack the enemy automatically, their construction and operation depend obviously on the living mental agent behind them. Therefore it is with this mind that we have to deal. Even if this be granted, however, another frequent statement is that *human nature does not change*. This statement may contain a certain measure of truth but even if human nature doesn't change there need not be so much of it. I would remind you that the rate of scientific progress during the last 100 years has been something altogether exceptional in the history of the world. May we not believe that just as the chemical experiments of Roger Bacon were at the time looked upon as a species of black art, but are now part of the possible knowledge of every Board School child, so certain fundamental spiritual truths, the knowledge of which was supposed to be confined to a few saints, sages and mystics, may become the common property of humanity? The evil power of mass suggestion is only too evident. As the Bishop of Calcutta has so well argued "why cannot the voice of truth be equally well disseminated among the people of the world?" In this connection one might refer to another apparent assumption, that men of science are superior to war suggestion. I am afraid, as an American might say, "I should smile." I have not observed that men of science are much less quarrelsome than other people. Personally I have not found that the study of chemistry has in itself enabled me more easily to control my temper or to suffer fools gladly.

Another assumption would seem to be that peace and democracy were desirable things to which all had a right much as we have to air and sunshine. On the contrary they are the rewards of great and persistent effort. Peace is the reward of righteousness. Democracy is the reward of self-discipline.

Another half truth is that war is due to a shortage of raw material on the part of certain nations. There is no shortage, *e.g.*, of tea. The Indian tea planter would be only too glad to sell as much as he could to anybody. It is not the present shortage but the fear of possible future shortage in case of war which is the trouble. Why then have War?

Actually the root cause of War lies deeper than these material difficulties. I would say that there are three lusts which are present in the subconscious mind of man, which lie at the basis of war, the lust of *power*, the lust of *prestige* and the lust of *possession*. These are all characteristic of the vulgar parvenu. I should like to read to you in contrast some words from one who cannot be accused of being a pacifist.

> "Greatness consists in not being the echo of others, in not throwing dust in anyone's eyes, in seeking only what is necessary for the welfare of the country and making straight for the goal..... All kinds of obstacles will be put in your way; but in the conviction that you are not great, but small and weak, and expecting no help to reach you from any quarter, you will, in the end, surmount all hindrances. And if any man, after that, calls you great, you will simply laugh in his face."

These are the words of Mustapha Kemal and I would remind you that he has made a nation out of Turkey, and that he has got his way in the Dardanelles without a single threat.

Another Dictator has made much play with the idea that war is a school of character. No doubt, great qualities are exhibited during war, so they are during earthquakes, floods, shipwrecks and mining disasters. Yet we do not look upon these as blessings. I cannot do better than quote again, this time from our King Emperor who spoke as follows after reviewing the Guards:

> "Humanity cries out for peace and the assurance of peace, and you will find in peace opportunities of duty and service as noble as any that bygone battlefields can show."

Let us not, therefore, as men of science make use of any of these half truths in our campaign for the abolition of war. I say for the abolition of *War* because the abolition of any particular weapon is only a part of our task. While it is arguable that there is little to choose between death or torture by poison gas and being smashed by a shell, it must be recognised that throughout the history of humanity certain limits have always been instinctively laid down. This was so even in the old Mosaic law and is implicit in the common expression "hitting below the

belt". Most people would sooner face a revolver than a bottle of vitriol.

Any joint effort, therefore, which can be made by the scientific workers of the world to limit the use of methods of warfare which involve death and torture to innocent and unprotected people is to be welcomed.

Nevertheless, the intelligence which is capable of investigating the furthest star or the smallest molecule, that has discovered means of communication which have annihilated space and time, can surely produce some result if it will honestly and humbly set itself to the study of these infernal forces which lie in the subconscious mind of man, and which need to be controlled by some higher energy if all the fair prospects of humanity are not to be obliterated in one hideous ruin. The famous psychiatrist Dr. Jung says "it is the psyche of man which makes wars......the most tremendous danger that man has to face is the power of his ideas. No cosmic power on earth ever destroyed ten million men in four years but man's psyche did it *and it can do it again*. I am afraid of one thing only, the thoughts of people. I have means of defence against things."

The following resolutions, put forward from the chair, were passed by the meeting:

"This meeting while pledging its support to every united effort which can be made to abolish methods of warfare which are repugnant to the common instinct of humanity recognises that the more important objective is the abolition of war itself.

To attain this end it would urge constant and strenuous activity on the part of thinkers and men of science.

In particular it records its opinion that more attention should be given by them to the study of the new economic conditions, which of necessity, accompany the advance of scientific research.

Of equal or greater importance is the study of means for controlling the evil effects of "mass suggestion," by the more powerful agency of widely disseminated right ideas through the adoption of an international system of education."

Rabies—A Note.

By S. P. Deshpande, G.B.V.C.

(N. S. Agricultural College Veterinary Hospital, Poona.)

RABIES is a very common and most unfortunate disease in Veterinary practice, especially in dogs. No attempt at treatment or relief can be made. If anything in the form of narcotics is given, it is likely to mask the characteristic symptoms and make diagnosis more difficult. Either the patient is allowed to die a natural death or destroyed when diagnosis is established beyond doubt.

In this article, the writer wishes to record certain symptoms of rabies which one comes across in daily practice. The symptoms of rabies, especially that of dumb form, are varied and are likely to escape one's notice, unless one has extensive practical experience.

There being no legislation about the control of stray dogs, this disease is playing a havoc taking a heavy toll of dogs and cattle in this country. Rabid cattle are not generally brought to hospitals. Dogs which are pet animals are generally brought to hospitals especially in cities; this disease is commonly observed among them. It is really a great menace to the dog world and in turn to human beings too. Costly and well-bred dogs stand a great chance of getting infection in spite of every precaution taken by the owner. For instance, a dog is being taken or led for a walk; some stray dog comes all of a sudden, bites it and disappears keeping the owner in doubt as to what type of dog it was: rabid or normal. We have had many such cases.

At this hospital, we have seen cases of rabies in horses, cows, buffaloes, sheep and goats, and dogs; in the latter we get a number of cases all the year round.

There are two forms of this disease, *viz.*, furious and dumb. Furious form is very easy to detect and the symptoms are clear, *viz.*, changed appearance, silly look, very red eyes and rushing at every object which comes into view. Such dogs do a great deal of damage biting several persons and animals and thus spreading infection. In cases of furious form, the writer has observed that the dog said to disappear from the owner's house for two or three days, come back with the symptoms described above in a most exhausted condition biting everything that comes across, in the compound. In this form dogs are seen eating their own fæces. If allowed, to live, these furious symptoms are followed by exhaustion, paralysis and death. Several cattle are infected by a dog suffering from this form of rabies. This is how cattle get infected.

In the dumb form, variety of symptoms are observed. Melancholy stage is common to both the forms and is generally passed unnoticed, duration being short and also being not in any way very diagnostic in the first instance; but when the disease advances, pronounced symptoms are shown and they will be as follows:—

> Uneasiness of a very peculiar type, congestion of conjunctiva, salivation from mouth, drooping of the head, changed behaviour, paralysis of the lower jaw, tongue of a lead colour, vague and listless expression, incoordination of the hind limbs, which afterwards develops into complete paralysis. Eyes sink. The animal is prostrate, breathing very heavily, gets convulsions, breathing becomes more distressing and sterterous, becomes exhausted and dies.

Wasting of muscles is very rapid in rabies so much so the dog becomes almost a skeleton in a few days' time. In many cases' appetite is totally suspended; but in some, the animal tries to lap and eat up to the last. In some cases, simply dry retching of a peculiar type and

uneasiness is noticed. The animal retches oft and on and a peculiar noise is produced. In some cases, simply a vague expression and slight change in behaviour are noticed for four or five or even more days and then sudden death with convulsions takes place.

Very rarely, the disease developes as a complication in another disease and that is generally distemper. The only explanation for such an occurrence is that the patient must be pre-infected and this disease coming up as a matter of loss of vitality or predisposition due to the original disease. We had one case with typical symptoms of distemper which was treated as an out-patient for some days. After some days' treatment, the patient showed symptoms of rabies and died; the brain was sent for microscopical examination and the case was confirmed as rabies. Temperature in almost all cases is elevated, in some cases upto 106° F. In some cases acute uneasiness is noticed and the animal does not rest in one position for even a few seconds. In such cases, death may take place within 24 hours.

In the case of dogs, males are affected more than the females—probably the former being fighters are liable to be exposed to infection.

Very small puppies, even two months old, are also affected. We have seen two cases of furious rabies in small pups.

In the case of cattle, it is observed that the disease comes up just after calving.

Also the place and depth of bite wound are points worth considering. The deeper the bite and the nearer to the brain, the greater the possibility of developing the disease. We have seen cases bitten on the nose and head to develop the disease within 25 days from the date of bite. Superficial bites elsewhere on the body have remote chance of causing infection. Also the quantity of poison injected is a factor worth considering; but unfortunately, this cannot be estimated.

Before concluding, it would not be out of place to mention some diseases which show at times the same symptoms as that of rabies and are likely to be mistaken for rabies *prima facia*.

(1) Sticking of bone in the throat: dry retching, salivation and uneasiness. (2) Acute Rheumatism: uneasiness, peculiar gait and animal snapping on palpitation. (3) Advanced cases of canine typhus: mouth held open due to ulceration of buccal membrane, salivation and exhaustion. (4) Milk apoplexy: uneasiness, dullness, gasping due to high temperature and suddenness of attack. (5) Ordinary convulsions of epilepsy when the animal is brought to hospital in the last stage and without history. (6) Very severe form of skin diseases. Irritation of the skin produces sometimes the same train of symptoms. (7) Severe form of canker, making the dog uneasy and to run with the head held low and flapping of ears. Even salivation is seen. (8) Motor or Cycle accident cases with no fracture but simply a smash: their wavering gait, salivation and dullness. (9) Nervous form of distemper. (10) Dislocation or paralysis of the lower jaw. (11) Vicious temperament. (12) Phosphorus or strychinine poisoning.

Résumé on the Literature of Indian Medicinal Plants.

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FREQUENT demands for characterisation of medicinal plants, for furnishing accurate information as to their distribution and life-history and for the supply of authentic specimens of genuine medicinal value, have led the writer to prepare a treatise on medicinal plants which will be published in due course. Attempts have been made from a very early period—as early as the Vedic period—to supply a work of such vital importance. Indeed, the origin of botanical science may be traced to the investigation of the medicinal properties of plants. Search for the healing properties of plants to mitigate the misery of human beings caused by various ailments led to the serious study of the plants around them. Thus developed the science of Ayurveda which forms an important part of Atharva Veda—the most ancient and celebrated treatise on Hindu medicine, although, the use of some plants is mentioned earlier in Rig Veda.

The works of Agnivesha, one of the six distinguished pupils of Ayurveda, resulted in the compilation of *Charaka-Samhita* by Charaka. *Sushruta-Samhita* then emanated from the pen of Sushruta, one of the brilliant disciples of Dhanvantari, the surgeon of heaven who took his birth in this country as Divadasa, King of Benares, who was reputed for his extraordinary knowledge in surgery and medicine. Thus *Charaka-* and *Sushruta-Samhitas* are the oldest treatises now extant and are of such great value to the Hindus that they are considered to be divine and beyond criticism. Among the contributions of this early period mention may be made of Bagbhatta's *Astanga-hridaya-Samhita*; *Chakradatta-Sangraha*; *Sarangadhara-Sangraha*; Vab Misra's *Vab Prokasa*; Madan Pal's *Raj Nighanta* and several other *Nighantas* and works on *Drabya Gunas* formed the basis of further studies on medicinal plants. Works of Makhzum-ul-Adwiya and other Hakims written in Persian and Urdu may be mentioned as valuable contributions to medical science in those old days by Mahommedans.

Foreign influence on the study of plants either for purely theoretical interest or for information on their medicinal values, dates back to the sixteenth century when Portuguese and Dutch scientists came to India. They may be considered as the pioneer workers in this field. Thomas Rives, Odardo Verbosa, Christobal DaCosta are among those who took lively interest in the study of drugs. But along with these it

will be necessary to include Garcia da Orta, whose *Coloquios dos simplas e drogas Le cousos medicinais India*—was published at Gôa in April 1563 and was in fact the third book printed in India. Van Rheedes' *Hortus Malabaricus* is the monumental work of twelve volumes on the study of Indian plants in the 17th century from 1678 onwards to 1703. During the 18th and 19th centuries, valuable contributions based on researches carried out on more or less modern lines, were made by a band of highly trained workers which enabled the recent investigators to make sufficient headway in the study and investigation of medicinal plants of this country. The earliest work of the 18th century of sufficient value is that of Georgens Everhardus Rumphius' *Het Amboinsch Kruyd-Boek* (1750). It was actually written by Rumf in the 17th century and the manuscript was left unpublished in the archives of the Dutch East India Company until Burman received permission to publish it. The name of William Roxburgh, " the father of Indian Botany "—the first Superintendent (1793–1813—whose book on Indian plants was actually published in 1820–1824 by Dr. Carey) of the then East India Company's garden—now, The Royal Botanic Garden, Calcutta, has become a household word in this country in recognition of his inimitable *Icones* and his *Flora Indica*. His works form the keystone for subsequent works on Indian plants. To confine ourselves mainly to the study of Indian medicinal plants—the names of the following workers may be mentioned: Dr. Fleming (1810), W. Ainslie, author of *Materia Medica of the Hindus* (1813) and its second edition—of 2 octavo volumes on *Materia Medica* (1825); Playfair (1833), Talif Sheriff, *Indian Materia Medica*, published in Calcutta, 18th to 19th century; Forbes Royle, *Vegetable Resources of India* (1839); and Sir William O. Shaughnessy of the Calcutta Medical College, who published in collaboration with Dr. Nathenial Wallich—next successor to Roxburgh as the Superintendent, Royal Botanic Garden, Calcutta —his much reputed work entitled *The Bengal Dispensatory and Pharmacopœia* (1844). Shaughnessy's publication led to the recognition of the value of many of the Indian medicinal plants by foreigners. Next followed Dr. Edward Balfour's *Cyclopedia of India* (1855)—a supplement to which was published in 1862. In the same year G. C. Birdwood wrote an account of *Vegetable Products of Bombay*. *The Useful Plants of India* by Heber Drury of Madras Army (1858–1869); Dr. Stewart's *Punjab Plants* (1869); Atkinson's *Economic Products of North-Western Frontier Provinces*; Dr. George Bidie's *Cinchona Cultivation in India* (1878); U. C. Dutt's *Hindu Materia Medica* (1870) written with the valued assistance of George King, the then Superintendent of the Royal Botanic Garden, Calcutta; Kanny Lall Dey's *Indigenous Drugs of India* (1896) and the notable contribution of B. C. Gupta's *Vanaushadi Darpaṇa*—the second edition of which appeared in 1917 (1324 B.S.), which appeared at the end of 19th century, are valuable contributions during the 18th and 19th centuries. But this period cannot be passed without mentioning the publication of Dymock's *Vegetable Materia Medica of India* (1883) and particularly *Pharmacographia Indica* (1890–1893) prepared in collaboration with Warden and Hooper; and Sir George Watt's *Dictionary of the Economic Products of India* in 6 volumes (1889–1893)—Index volume of which appeared in 1896—are the two outstanding works containing valuable information. These works embody the results of the labours of the two well-known investigators of the latter part of the 19th century. Their contributions will prove invaluable for research workers in their further investigations in this field. In 1918 the voluminous works on medicinal plants by Kirthikar and Basu were published, wherein the authors have made a praiseworthy attempt to compile a detailed description of plants together with notes on their medicinal value. A revised edition of this work with considerable emendations and modifications is ready for publication. The illustrations accompanying the text are of considerable advantage for the identification of the plants. Apart from this work, *Indian Materia Medica* by K. M. Nardkarni—a revised edition of which appeared in 1926—deals exhaustively with the medicinal properties of plants. The botanical aspect of this book requires to be corrected and improved upon. Col. R. N. Chopra, in his book on *Indigenous Drugs of India* (1933) has furnished up-to-date information on the medicinal properties of plants. The botanical information on individual species might have been incorporated with advantage to render this work to be of more general and practical value. The need for bringing out suitable publications to remedy the deficiency of botanical information in treatises on medicinal plants will be appreciated. In the volume now under preparation, the family characters and specific descriptions are given; suitable illustrations and notes on distribution together with brief references to their medicinal properties have been incorporated. It is hoped that this hand-book may serve as a guide both to the professionals and to the amateurs in gathering authentic materials in the field and in identifying medicinal plants. Sir David Prain's *Bengal Plants* proved useful to the author in his work.

For valuable suggestion and addition of specific descriptions of plants common to this Province—specific descriptions which fill a gap in such publications as *Bengal Plants*, as stated by Sir David himself—the author offers his grateful thanks to Sir David Prain, Lt.-Col., KT., C.M.G., C.I.E., M.A., D.SC., LL.D., F.R.S. I am indeed deeply indepted to Sir David Prain also for making necessary emendations in this contribution. My thanks are also due to Babu Ekkari Ghose, author of *Krisitatwa* for his valuable assistance in the preparation of the book on medicinal plants.

RESEARCH NOTES.

MATHEMATICAL AND PHYSICAL.

A Condition for the Complete Reducibility of Representation of Finite and Infinitesimal Groups.—Brauer (*Math. Zeit.*, B. 41, 330–339) has given a set of conditions for all representations of a group (it may be a half group—*i.e.*, the associative law of multiplication holds and the existence of an inverse element of an element need not be true) to be completely irreducible. If G is the group, then the condition he gives is that it is sufficient for complete reducibility of *all* representations, if the same is true for all representations $H = \begin{bmatrix} A & 0 \\ E & D \end{bmatrix}$, where A and D are irreducible, *i.e.*, he has reduced the problem to the case where the representation consists of only two irreducible parts. The method of proof can also be applied to obtain a set of conditions for the complete irreducibility of a given representation (not *all*). He also proves the corresponding theorem for infinitesimal groups. With the same method he obtains that all representations of a half-simple infinitesimal group are completely reducible, a result which was proved earlier by Wander Waarden and Casimir, by infinitesimal methods using known formula about the structure of such a group. His methods of proof are simple and makes use of elementary results from the theory of group representations.

K. V. I.

On Certain Tamberian Theorems, with Asymptotic Values of Exponential Character.—Avakumovic and Karamata (*Math. Zeit.*, B. 42, 345–356) have obtained certain sharp results concerning the asymptotic relation between the value of the Laplacian transform

$$J(\sigma) = \frac{1}{\sigma}\int_0^\infty e^{-\sigma t}\, d\{A(t)\} \text{ and } A(t).$$

Such kind of problems were at first considered by Hardy and Ramanujan. The authors have proved that if $J(\sigma) = Ax^k e^x$, then

$$\log A(t) \sim 2\sqrt{t}. \quad \{\sigma = \frac{1}{x} \to 0\}.$$

They have also obtained the finer inequality

$$\log A(t) = 2\sqrt{t} + 0\,[t^{\frac{1}{4}} \sqrt{\log t}],$$

with the assumption that $A(t)$ is monotonic. (A less stringent condition also is sufficient.) Certain generalisations of these theorems are also given. The authors are publishing as part II their results when

$J(\sigma) = e^{x\alpha} L(x)\,[1 + 0(1)]$. Where $L(x)$ is a slowly increasing function.

K. V. I.

Measurement of the Angular Momentum of Light.—It follows from the electromagnetic theory of light that a beam of polarised light exerts a torque on a plate of doubly refracting crystal which alters its state of polarisation. The same quantitative result is obtained if an angular momentum of $\frac{h}{2\pi}$ is ascribed to a quantum of left-circularly polarised light. This torque has been now experimentally detected in spite of its smallness by Richard A. Beth. Details of the experiment are given in his paper in the *Physical Review*, 1936, **50**, 115. The underlying idea was to send a beam of suitably polarised light through a quartz wave plate which was suspended in vacuum by means of a fine quartz fibre. To increase the torque acting on the plate, the light, after passing once through the suspended wave plate, was reflected so as to pass again through the plate in the opposite direction. The whole apparatus was mounted on heavy cast iron brackets attached to a brick pier. The one inch circular wave plate was hung up by means of a quartz thread 25 cm. long hanging in a quarter-inch hole bored through a copper cylinder of two inches diameter. The upper end of the fibre was attached by means of shellac to a ground conical stopper which fitted the cylinder and was made air-tight with Apiezon grease. Light from a three-millimetre tungsten ribbon filament F was focussed by a fused quartz lens L through a large Nicol prism N and then through a fixed quarter wave plate B which was attached outside the vacuum chamber in a brass ring so that it could be rotated by known amounts. The light then passed through a fused quartz window W at the bottom of the vacuum chamber, then through the suspended plate M and came to a focus at the aluminium reflecting layer at the top of another fixed quarter wave plate T above M. The suspended plate itself was a half-wave plate for that wave-length λ_0 for which B and T were quarter-wave plates. The axes of M were at right angles to those of B and T. The light path was not more than 10° to the vertical at any point while the axis of the light beam was vertical. The rotation of the plate M was observed by means of a small mirror *m* attached to the fibre and a telescope and scale arrangement. With this arrangement no light energy reached the fibre and most of the light was reflected out of the vacuum chamber so that fluctuations due to unequal heating of the fibre and the light pressure on the small mirror *m* were minimised. The effect of other wave-lengths than λ_0 was also calculated. The results of about 120 observations showed that the torque observed was of the sign and order of magnitude required by theory.

T. S. S.

On a Simple Nuclear Model.—Treating the nucleus as a gas obeying Fermi Statistics and consisting of protons and neutrons, K. Bechert has developed a simple theory (*Zeits. für Physik.*, 1936, **101**, 721) which correctly gives the variation of the chemical atomic weight A with the nuclear charge Z. The potential energy of the neutrons is taken as $V_\nu(r) = -C$ for $r \leqslant a$ and 0 for $r \geqslant a$. The radius of the nucleus 'a' is set equal to $a_p \sqrt[3]{A}$ where A is the atomic weight and a_p should be of the order of 10^{-13} cm. The potential energy of the protons $V\pi$ is supposed to consist of two terms, one V_c due to the Coulomb repulsion between protons and another $V_{\pi N}$ due to the attraction between protons and neutrons. V_c satisfies the Poisson equation while $V_{\pi N}$ is taken to be $= -C$ for $r \leqslant a$ and 0 for $r \geqslant a$. The essential boundary condition is taken to be that V_π should be finite at $r = 0$. With these assumptions the final formula is deduced that

$$(1) \quad \frac{A}{Z} = 2 + 0\cdot600\,\zeta^{2/3} + 0\cdot115\,\zeta^{4/3} + 0\cdot019\,\xi^2 +$$

where $\zeta = \dfrac{Z}{125\cdot1033} < 1$ and $\xi = \dfrac{ar}{\mu}$ with μ

$$= \frac{3^{2/3}h^2}{2^{13/3}\pi^{1/3}\, m\, e^2\, Z^{1/3}}.$$

The theory also gives the formula

$$(2) \quad \frac{N}{Z} \approx 1 + 0\cdot03 \frac{Z}{\sqrt[3]{A}} \text{ where } N = A - Z$$

which is similar to the equation $\dfrac{N}{Z} = C_1 + C_2 \dfrac{Z}{\sqrt[3]{A}}$ given by Heisenberg. a_p comes out to be equal to 5.6×10^{-14} cm. so that the nuclear radii come out to $2\frac{1}{2}$ times smaller than those given by Gamow. The variation of the chemical atomic weight with nuclear charge is however very well represented by the formula (1) deduced from this theory.

T. S. S.

Micro-Luminescence of Chemical Reactions. The phenomenon of chemi-luminescence, where a part of the energy of reaction appears as light, has been studied extensively in a number of cases, with the aid of spectral and other common devices. By using instead, a highly sensitive photo-electric counter, R. Audubert (*Journ. de Chem Phys.*, 1936, **33**, 507) has now discovered that a large number of common reactions such as the neutralisation of a strong acid by a strong base, are accompanied by an extremely feeble emission of light in the ultra-violet region about 2000 Å. The essential character of this micro-luminescence is that the quantum of energy liberated is considerable and of the order of 150,000 cal. per gram mole. Such high values cannot easily be accounted for from the point of view of classical chemical mechanics. The author has tentatively suggested among others that this may be due to privileged collisions between highly activated molecules (collisions of the fourth kind !)

M. A. G.

Geologic Deductions from a Thermal Equation. It is generally admitted that radioactivity the chief source of thermal energy—is largely confined to the outer parts of the lithosphere. Since the rocks that contain the radioactive elements are continuously involved in erosion and deposition, the source of energy is migratory to a certain extent. Such migration of material causes variation in the horizontal and vertical distribution of radio-active elements which according to Justin De Lury (*Journal of Geology*, **44**, No. 4) results in differential thermal effects of great importance. After discussing the views held by different authors, he has attempted to derive a thermal equation to explain the causes of the frequent distortion of the sial layer. By a series of arguments he tries to correlate his geophysical ideas with the major problems of petrogeneses. According to him batholiths are large masses of horizontally moving magma, generated not at great depths but at comparatively shallow regions. He also questions the universal applicability of the idea of differentiation, as the only cause for the variation noticed in igneous rocks, and suggests that assimilation may have played an equally important rôle.

BIOLOGICAL.

Androstendiol, a Bisexual Hormone.—Prof. Dr. Adolf Butenandt of Danzig, a world authority on the chemistry of Sex Hormones, has an interesting note in *Forschungen und Fortschritte* (12, No. 17, 218) on the preparation of what he terms a "bisexual hormone," that is, a hormone which on administration to animals is capable of developing both the male and the female sex characteristics. The male sex hormone, Testosteron, is now known to be an unsaturated tetracyclic oxyketone of the formula $C_{19}H_{28}O_2$, while the female sex hormone, Oestradiol, is an unsaturated tetracyclic alcohol represented by $C_{18}H_{24}O_2$. Oestradiol can therefore be theoretically obtained by the simple removal of a molecule of methane CH_4 from Testosteron. It is probable that this transformation actually takes place in nature because a very rich source of Oestradiol is, paradoxically enough, the urine of stallions.

This close chemical relationship of the two sex hormones led Butenandt and his co-workers to consider the possibility of the synthesis of a bisexual hormone. It has been known for some time that the catalytic hydrogenation of Oestradiol saturates its double bonds and yields a product, Hexahydro-œstradiol, which not only has none of the physiological properties of the parent substance but on the contrary exhibits to a slight degree the properties of the male sex hormone. More recently, it has been shown that the introduction of an oxygen atom to a molecule of Testosteron yields a product, Oxo-testosteron, which on administration to female mice induces œstrus.

These experimental results were followed by Butenandt who, starting from Cholestrin, has now synthesised an unsaturated alcohol which he names Androstendiol. This substance on administration to castrated male animals induces in them the development of the male sex organs. The animals also develop the secondary male characteristics. Androstendiol, on the other hand, when administered to a castrated female animal brings about the corresponding development of the female sex characteristics in the animal.

The structural formulæ of these complex substances (given in the original paper) reveal that although their physiological actions are so profoundly different, yet their chemical relationship to one another is very close indeed. Further work on Androstendiol and its transformations is in progress.

EMMENNAR.

Nitrogen Nutrition of Sugarcane.—(U.K. Das, *Plant Physiol.*, 1936, **11**, 251-31 F).—Plots of sugarcane, variety H 109, were grown for 24 months at the Experimental Station in Honolulu at 3 levels of N-fertilisation: 133, 266, 645 lbs. N per acre applied as $(NH_4)_2SO_4$. Increased applications of N increase the size of the leaf, the rate of leaf and joint formation and the rate of elongation. N favours tillering and increases the yield of cane, but in the high N series the yield was depressed considerably in the later months because of mortality of cane from lodging. Water, reducing sugars and electrical conductivity of the sap increase with increasing N applications. Sucrose determinations showed that it decreases with increasing N applications. Seasonal variations of these

constituents were greater than those due to treatment alone. Increasing N applications produce no clear cut differences in the polysaccharide content or the pH of the expresssed juice. The higher the application of N, the greater the N content of the cane tissue. The lower the application of N, the more efficiently the cane removes the N from the soil. The medium N series produced a much greater amount of dry matter and sucrose than either the low or the high N series. The variations observed are explained on the basis of the effect of N applications on the absorption of ash constituents which modify the hydration capacity of the tissue colloids. This directly affects the conditions of the soluble compounds of the cell sap and appears to control the relative elaboration of the various carbohydrates in the tissue through its influence on the enzyme complex of the plant.

The Effect of Liming upon the Yield and Quality of Sugarcane.—Somewhat striking results following the application of lime to certain sugarcane soils in the Phillipines are reported in a study by Vicente B. Arancillo (*The Phillipine Agriculturist*, **24**, No. 6). The pH value of the soils before liming was about 6·6 and the application of lime at the rate of a ton per acre brought the pH value up to 7·73. Limed at this rate the germination was found to be better and the crop more vigorous, though the lime had no effect on the maturity of the plants. The yield of cane was the highest on the plot limed at one ton per acre being about 6·4 tons more than the control and about 5·6 tons more than plots limed at the higher rate of four tons per acre. The yield of sugar per ton of cane was however not affected, such differences as were noticed not being significant. Computed in money values the one ton limed plot gave the highest gain while those limed at two and four tons per acre both resulted in big loss. The soils dealt with were heavy clay loams, the lime applied contained 45·86 per cent. CaO and the variety of cane used was POJ 2878.

A. K. Y.

Heat Sterilisation of Mangoes and Guavas for Fruit Flies.—Certain mango varieties and guavas grown in Porto Rico are said to be excluded from importation into the U. S. A. on account of their being infested with the fruit flies and a rather interesting experiment (abstracted in *Exp. Stn. Record*, **74**, No. 4) to get over this difficulty consists in subjecting consignments to heat sterilisation at a temperature of 43° C. in a circulating atmosphere saturated with moisture. It was found that the treatment effectively kills the eggs, maggots and pupæ of the fruit flies without unfavourably affecting the flavour, appearance or keeping qualities of the fruit, provided it is placed afterwards in refrigeration. It was also seen that sterilasation for 4 hours was quite as effective as the 8 hour sterilasation affording thereby a large margin of safety. Mangoes could be freed from infestation whether crated in their natural state or wrapped in paper and crated. The method of course aims only at killing eggs, etc., already inside the fruit and does not relate to the infinitely more important matter of preventing the entry and infestation by the flies. The fruit flies referred to in the study are identified as *Anastrepha fraterculus* and *Anastrepha unipuncta* attacking mangoes and guavas respectively.

A. K. Y.

Haemoproteids of Indian Birds.—(*Proc. Ind. Acad. Sci.*, 2, No. 5).—Col. Froilano de Mello in collaboration with a number of his pupils has recently described 23 new species of *Hæmoproteus* from as many birds from Portuguese India. The descriptions are not accompanied by figures and the schizogony stages have not been observed in any case. The morphology of the gametocytes has been adequately described. In the genus *Hæmoproteus* only gametocytes occur in the red blood-corpuscles of peripheral blood, schizogony taking place in the endothelial cells of the blood-vessels of various internal organs, while in *Plasmodium* (*Proteosoma*) schizogony takes place in the red blood-corpuscles and thus schizonts, merozoites and gametocytes can be found in them. Col. de Mello appears to have concluded that all the forms described by him are species of *Hæmoproteus* from not having come across schizogony stages in the peripheral blood. But it is not safe to do so. In the absence of definite knowledge about the occurrence of schizogony in the internal organs, we are left to judge from the morphology of the parasites themselves and their occurrence in relation to the nucleus of the infected corpuscle. In *Hæmoproteus* the organism is halter-shaped and grows round the nucleus without displacing it, while in *Plasmodium* (*Proteosoma*) the nucleus is ordinarily pushed to one side by the invading organism. Judged by this criterion as many as 14 out of the 23 species described would seem to belong to the genus *Plasmodium*, though in several of these the gametocytes are said to be halter-shaped. The systematic position of these species must consequently be regarded as *sub judice*.

B. L. B.

Coccidia of Lizards.—Dr. Setna reported a new Coccidium from the gall-bladder of the common lizard, *Hemidactylus flaviviridis* discovered by Miss R. H. Bana at Bombay (*Current Science*, 1933, p. 97). Col. R. Knowles and Dr. B. M. Das Gupta described the oöcysts of three species of *Eimeria* from the same host at Calcutta (*Ind. Journ. Med. Res.*, 1935, 22) and designated them as species A, B, C. Discussing the previous literature, they thought that their 'species A' might correspond to *Eimeria raillieti* Léger, 1898, from *Anguis fragilis*, but were not able to secure the orginal paper in India, nor could it be 'unearthed in London'. The writer of this note has found out that this inability to unearth the paper is due to the reference having been wrongly cited by Wenyon (1926) as *Ann. Mus. Hist. Nat. Marseilles* instead of *Bull. Mus. Marseilles*, I, pp. 71–123. This latter is not available in India, but a description of the species was given by Léger (1899) in *C. R. Soc. Biol.*, (xi), I, pp. 309-311, and an abstract is available in *Wiegmann's Archiv* (1904, pt. 3, 115). I have carefully compared this with Knowles and Das Gupta's description of their 'species A', and find that the oöcysts correspond to those of *E. raillieti* in size, but those of the latter are oval and show a small button-like protruberance at one pole. I am therefore naming it elsewhere as *E. knowlesii*.

Their 'species B' is identical with Setna and Bana's *E. flaviviridis*, a full description of which has been published in *Journ. Roy. Micros. Soc.*, 1935, **55**, 256–260, and fully illustrated with diagrams of all the stages. The species shows a very close resemblance to *E. agamæ* Laveran and Pettit, 1910, as regards the occurrence of both schizogony and sporogony in the gall-bladder and bile ducts, and in the form and dimensions of the oöcysts, but differs as regards the form of the sporocysts. The latter are fusiform in *E. agamæ* and ovoid in *E. flaviviridis*.

Knowles and Das Gupta have already named their 'species C' as *E. hemidactyli*.

B. L. B.

The Kinetochore or Spindle Fibre Locus in Amphiuma.—The structure and significance of the Kinetochore are discussed in a paper by Franz Schrader (*Biol. Bull.*, June 1936, **70**, No. 3, 484). The term kinetochore was first applied by Sharp for a special region in the chromosome to which the spindle fibre is attached. It serves as a "chromosomal base for the connection between the chromosome and the pole". It consists of a deeply staining chromatoid body, lodged in an achromatic pit. Each tetrad in meiosis has two achromatic pits with two spherules each, while in the second spermatocyte, each dyad has two kinetochores with a spindle spherule in each. Staining reactions show that the kinetochore is quite distinct from an ordinary chromomere.

Fresh-Water Medusae from China.—Interesting experiments on Fresh-Water medusæ of the genus *Craspedacusta* occurring in a pond in Amoy, South China, are recorded in a paper by D. S. Tang, P. F. Yang and T. C. Fang (*Lingnan Sci. Journ.*, July 1936, 15, No. 3, p. 445). Probably allied to *C. kawaii* and *C. sowerbii*, the medusæ were found in association with Potamogeton, the only flowering plant found in the pond. The animals were found to injest Cyclops and Volvox. They were extremely sensitive to temperature changes, even slight departures for 28° C. affecting their movements adversely. So also were changes in salinity and pH of the medium found to have adverse effects on them. The animals were seen to react towards light also in the same manner.

SCIENCE NOTES.

Surface Tensions by Bubble-Counting.—Messrs. R. N. Das and H. C. Bhuyan, Cotton College Laboratory, Gauhati, write :—

A new but comparatively simple method of measuring relative surface tensions of liquids has been developed in our Laboratory. The same volume of air is forced through a jet immersed successively in the two liquids to be compared and the numbers of bubbles escaping are counted in each case. If n_1 and T_1 represent the number of bubbles and the surface tension respectively of the first liquid and n_2, T_2 those of the second it has been found that the relation $n_1 T_1 = n_2 T_2$ holds good. Some ten organic liquids have been tried using water as the standard and the surface tensions so found have agreed with the standard values to within 2%. Exact agreement need not however be expected as the standard values given in tables of physical constants are obtained by different methods which vary amongst themselves by about the above range and in our case the measured surface tensions will be dependent on the value chosen for water. The air forcing device was a sort of manometric arrangement where the limb connected to the jet had three bulbs and the bubbles were counted only during the time in which the air of the middle bulb was being forced out. Varying the depth of the jet from 2 to 6 cm., the number of bubbles was found to be independent of the depth of immersion but it is a complicated function of not only the jet diameter but also of the shape of the tapering portion of the jet. A drawn-out glass tube was broken with a fine cut to obtain two jets of identical orifice but differing in the shape of the tapering portion just above the jet-mouth. Other conditions being alike, the two jets showed a difference in the number of bubbles with the same liquid. But it is remarkable that with either of them we obtained the correct values for surface tensions for the whole series of substances investigated. To test the method for small variations we measured the surface tensions of NaCl solutions at various concentrations and the slope of the tension-concentration curve came out to be exactly 1.53.

The method is interesting in that it requires very simple apparatus and makes the least demand on the time and skill of the observer. It will be found specially useful where surface tension measurements are involved as routine work.

* * *

Crab-Fishing in the Ceded Districts.—Mr. A. Ramakrishna Reddy, B.Sc. (Hons.), Annamalai University, Annamalainagar, writes :—

Paratelphusa (*Oziotelphusa*) *hydrodromus* (Herbst)[1] is the commonest edible crab of the Ceded Districts. It is fished on a small scale by the poorer classes for domestic use; but not for commercial exploitation. Its flesh is greatly relished and during the months of March, April, May and June, it is fished very extensively.

The species lives in deep burrows which have a peculiarly oblique descent on the muddy banks of ponds and small canals.[2] Often the crab is covered by patches of muddy colour characteristic of its environment. At one's approach it crawls back into its burrow with great rapidity.

Krauss[3] describes that in Natal *Scylla serrata* (Fôrskål) is captured by spear throwing. Sunder

[1] *Scylla serrata* (Fôrskål and *Varuna litterata* (Faber) are the commonest edible crabs of Lower Bengal. See S. L. Hora, *Proc. Zool. Soc. London*, 1933, 881–884.

[2] Compare the habits of *Scylla serrata*. See S.L. Hora, *Curr. Sci.*, 1933, **1**, 881.

[3] *A History of Crustacea* by Stebbing, p. 69.

Lal Hora[4] describes an implement consisting of a bent ironhook lashed into a split bamboo which is used for capturing *Scylla serrata* at Uttarbhag, Lower Bengal. In Ceded Districts the methods of fishing are somewhat different and in a way more efficient. A fairly long tough stick with a swollen node at one end is taken and fitted into a hollow suitable bamboo so that the bamboo barrel can be easily moved up and down this stick. The node at the lower end prevents the bamboo barrel from slipping down. If the node is not sufficiently big to prevent this slipping it is reinforced by winding a rope around it (Fig. 1).

For capturing the crab, this implement is passed down the hole and when the crab catches hold of the lower end by means of its powerful claws the bamboo barrel is pushed down and pressed hard against its chelæ. Subsequently without releasing the pressure exerted by the bamboo barrel the crab is pulled out. When legs other than the great chelæ are caught under the bamboo barrel the crab readily casts them off and escapes. But if the chelæ are trapped, it is not so easy for the crab to break them off. Of course, in a very few cases it does succeed to break off even the great chelæ, in its frantic efforts for freedom. In many cases, however, the barrel falls over a part or the whole of the body of the crab so that escape of the crab is rendered impossible. By this device the crab when once it catches hold of the stick is prevented from escaping during the process of being pulled out, by the action of the bamboo barrel. Further the crabs in many cases are captured unmutilated. Their powerful claws are, however, broken as soon as they are captured.

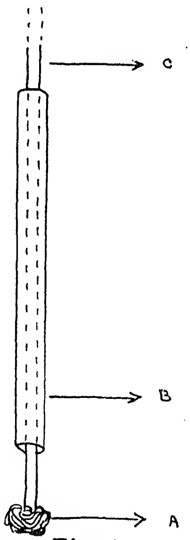

Fig. 1.

A. Swollen node.
B. Bamboo barrel.
C. A portion of the tough stick.

In shallow water when young ones of *Paratelphusa* are present in large crowds, circular nets are used for fishing them. They are captured in large quantities along with small fishes. During the hot months when the pools and ponds begin to dry up these crabs collect in large numbers in wet places towards the centre and are very easily fished out by the hand. The real fishing season for crabs in Lower Bengal according to Sunder Lal Hora,[5] is during the months of May and June, but in those parts the crab fishing extends over the months of March, April and May.

* * *

[4] S. L. Hora, "Crab Fishing at Uttarbhag, Lower Bengal," *Curr. Sci.*, 1935, **3**, 543.

[5] S. L. Hora, *Jour. Proc. As. Soc. Bengal* (N. S.), 1932-33, **28**, 197-205.

Facts about the Sugar Industry of Australia.—Some important features of sugarcane cultivation and sugar manufacture in Australia observed by T. S. Venkataraman, the Government Sugarcane Expert, in the course of his recent visit to that country are described by him in *Livestock and Agriculture in India*, **6**, Part 3. Attention may be drawn to the following: The cultivation has been extensively mechanised with the result that one farmer with the help of only four labourers could produce 5,000 tons of cane (we are not told how many acres this represents, it is probably not less than some 50 acres); many a mechanical device was due to the ingenuity of the farmers themselves, being later improved and perfected by the manufacturer. Under irrigation, yields go up to 7 tons of sugar per acre, though for the country as a whole it is only about 2½ tons. Ratooning is general and cane is cut very low to induce growth from buds well below the surface, this having been found most favourable for ratoon-cane. Cultivation is practically on the level, there being no earthing up of cane at all; irrigation is probably by mere flooding, though this is not definitely stated. Badila (called in India by the name of Fiji B) is the variety of cane grown mainly. A point of great interest is the use of molasses as manure for cane, the stuff being applied directly to the land at the rate of 5 to 8 tons per acre and cane planted within a month after the application; we should have a reference made to a curious case of molasses ridding a field of a pest of worms, making a 40 ton crop possible where previously it was difficult to grow any cane. This is a subject well worth going into further. Labour on the cane fields is paid at $ 16 (or about Rs. 9) per day. In fighting diseases, importance is attached mainly to the raising of resistant varieties but the significant remark is made that susceptibility is often a question of environment. Methods of disease and pest control are very thorough, these being strengthened by adequate legislation. Steeping of cane setts in hot water at 52° C., correcting the acidity of solid varietal rotation have been important cultural methods of disease control. The control of pests by parasites, checking the white-ant pest with arsenic-soaked saw dust buried in the soil and the "grey bark beetle" by the giant toad, *Bufo Marinus*, are other interesting items of information. The spread of the Co. canes in that country notably the Co. 291 was noteworthy; it had yielded up to 50 tons of cane per acre. We wish this interesting note was more detailed.

* * *

Improvement of Crops in India.—A press note recently issued by the Director of Public Information gives a review of the research activities relating to the improvement of crops, carried out under the auspices of the Imperial Council of Agricultural Research.

The area under improved varieties of crops is now over 16,000,000 acres, representing an increase of over 20 per cent. in the course of the last two years. The corresponding area in the States rose by 12 per cent. last year. These figures are certainly an underestimate as it is

impossible to ascertain the full extent of the natural spread of improved varieties, once they become popular.

The progress of work on the production of improved varieties of crops, carried out by the Provincial Agricultural Departments has been considerably accelerated through the assistance rendered by the Imperial Council of Agricultural Research. The Council's responsibility extends only to the encouragement and co-ordination of the work of the Provincial Agricultural Departments and the dissemination of scientific information.

Improvement of crops consists in evolving varieties having superior quality, heavier yielding capacity, disease resistance and better adaptability to environment. The variety selected usually combines several of these factors.

A good many crops have come under the purview of the Imperial Council, rice, wheat, sugarcane, cotton, tobacco, etc. Research stations for improving rice have been established in Madras, Bengal, Bihar, United Provinces, Central Presidency and Burma. Strains suitable for cultivation in the various provinces have been evolved. To mention an instance, the Madras variety known as *G. E. B.* 24, which has proved a great success, is distributed to the extent of over 300 tons of rice seed per season in the Madras Presidency by the Agricultural Department, while the seed farms under departmental supervision provide seed for 300,000 acres or more. The researches conducted at Pusa and Lyallpur on wheat have resulted in bringing a sixth of the total area under improved varieties. The variety known as Cross 518 has been found to be ideal for rich soils, while for '*barani*' (un-irrigated) conditions, the variety known as 9*D* has given good results. Investigations on rust-resistant strains are being conducted under the auspices of the Council. Remarkable progress has been made with respect to the cultivation of sugarcane. Over 70 per cent. of the area is now under improved varieties. The results achieved by the researches at the Coimbatore Station are widely known. The latest development is the successful production of Jowar—sugarcane hybrids. The Council has recently decided to finance research on the insect pests of sugarcane and the work will be carried out at the Imperial Institute of Agricultural Research, New Delhi. On the technological side, the Central Imperial Institute of Sugar Technology has been established in Cawnpore, for the training of technical staff for sugar factories. Regarding tobacco, another important money crop, the researches carried out at Pusa have resulted in the successful production of hybrids between American and Indian varieties, suitable for cigarette manufacture. Over 2,500 flue-curing barns have been established all over India, mainly in the Guntur District and a special tobacco research station will soon be founded for the study of quality of tobacco. A remarkable expansion in fruit industry has recently been witnessed. Successful storage and transport experiments have been made in Bombay on mangoes and oranges, and a grant has been made to Baluchistan for an experimental fruit canning plant.

The researches on crops originated by the Imperial Council of Agricultural Research extends beyond the mere evolution of crops. The work includes researches on soils, crop pests, plant diseases, soil management, agricultural meteorology and production of efficient implements useful in agricultural practice.

* * *

Recent Researches at the Institute of Agricultural Research.—An efficient and simple method has been evolved by the Imperial Institute of Agricultural Research for the manufacture of clean and attractive coloured *gur* and for the manufacture of white sugar by the open method which will be within the means of the sugarcane grower (Press note from the Director of Public Information, Simla). The method and the equipment are so flexible that the ryot can manufacture good quality *gur* or sugar according to the needs of the market. It is said that this new method which is not a competitor to factory production, has a promising future and is destined to play its rôle in the future of sugar industry of India.

The Institute has also succeeded in developing starter cultures which are an improvement in practical dairying for producing rich flavour and aroma in butter. These have been tested in a laboratory and are used on a large scale in Bangalore Dairy with very satisfactory results.

A simple method for the cheap production, from locally available materials, of what is well known as *E. C.*, a chlorine disinfectant, has been developed and perfected. It is said that this is now being used extensively as disinfectant in hospitals, railways, sugar factories, and a number of other places.

* * *

Indian Central Cotton Committee.—An important matter reported at the 32nd meeting of the Indian Central Cotton Committee, held on the 13th and 14th January 1936, is the securing of a larger market for Indian cotton in the U. K. Thanks to the endeavours of the Lancashire-Indian Cotton Committee; a more intensive propaganda to the same end is also foreshadowed. The discussions relating to the trade in cotton centred round legislation for checking malpractices, by amendments to the Cotton Ginning and Pressing Act, by the regulation and control of Cotton Options and the zoning of areas for particular varieties of cotton. Some very flagrant cases were referred to, one especially of cotton having been watered to the extent of 20 per cent. in one of the godowns! In regard to cotton research which the Committee has been financing we are glad to note that the various grants are all to be continued even though this entails the drawing from the Committee's reserves to the extent of Rs. 3 lakhs. The discovery by the Cotton Physiologist of an organism in the tissues of the cotton plant which he was inclined to claim as a causal organism for the well-known maladies of American Cotton grown in this country and which aroused considerable interest at the time was decided to be put to further scrutiny. The Technological Institute has taken up the investigation of the cellulose content of different cottons, the objective being their industrial utilisation for the making of artificial silk;

we are particularly gratified at this widening of the scope of the Institute; it happens to be a step we have strongly urged. A rather exciting discussion over certain criticisms of the work and policy of the Committee made in England by Sir Albert Howard who put the Committee on its mettle was a feature of the meeting. The Committee naturally joined issue in a spirited manner and one cannot help thinking that Sir Albert's criticism was quite unjustified. One may concede much to the claims made for the Indore process of compost-making without subscribing to his view that the Cotton Committee should popularise it far and wide and that the expenditure on cotton pest investigations and seed distribution schemes is a waste of money. Such a view to our mind shows a wrong understanding of the requirements of the situation and of the scope of this Committee *vis-à-vis* the regular Agricultural Departments. Thanks to the efficient publicity service of the Committee, a resumé of these proceedings has already appeared in the press.

* * *

The National Geographic Society.—Dr. Irvine C. Gardner, American scientist, who under the auspices of the National Geographic Society and the National Bureau of Standards, led an expedition to U. S. S. R. to study the total eclipse of the sun on June 19, recently returned to America with 8 large pictures of the recent total eclipse of the sun and its corona. The photographs are believed to compare favourably with the best photographs made during the previous eclipses.

Dr. Gardner, accompanied by his wife who is also a scientist, made the photographs at Ak Bulak, U. S. S. R., on June 19, with a huge camera equipped with a lens system which he had invented for the purpose.

Dr. Gardner obtained both black-and-white and natural colour photographs of the sun's corona or halo with exposures ranging from 1 to 16 seconds. As a result of frequent rehearsals Dr. and Mrs. Gardner were able to utilise 56 of the 117 seconds of the total eclipse in actually making exposures, requiring 61 seconds for the changing of plate holders, and the removal and replacement of dark slides.

Dr. Gardner developed his valuable films and plates at Ak Bulak and brought them by hand to the United States. There has been no time so far for the detailed study of the images, but he expressed himself as highly pleased with the apparent results. Even the 1-second exposures show the corona extending hundreds of thousands of miles outward from the disk of the sun; while the 16-second exposures show some streaks of light in the corona extending from the disk more than $1\frac{3}{4}$ times the sun's diameter. These pearly pencils of light are probably well over a million miles in length.

All of the photographs show apparent nicks in the edge of the sun's disk. These were caused by extreme brilliance of the 'prominence'—intensely hot flames which lick out from the sun's surface for perhaps thousands of miles. These flames are believed to be ignited hydrogen gas.

* * *

Blood Parasites of the Indian Birds.—At the ordinary monthly meeting of the Royal Asiatic Society of Bengal, held on Monday the 7th September, Col. I. Froilano de Mello gave a paper bearing on his contributions to the study of Blood Parasites of the Indian Birds. Col. De Mello gave a complete list of the Hemoparasites recorded from Indian birds, and discussed their classification and relationship. In addition, he described a number of species of Hæmoproteids which he has studied in detail from Nova Gôa and other places.

The following were balloted for as ordinary members:—(1) The Hon'ble Sir Bijay Prasad Singh Roy, KT., (2) Jadunath Sinha, M.A., Ph.D., (3) Daulat Ram, (4) Rai Bahadur Kumar Nath Bagchi, B.SC., M.B. (Cal.), D.T.M. (Cal. and L'pool), F.I.C. (Lond.), and (5) N. T. Williams.

* * *

At the third ordinary meeting of the **Indian Chemical Society**, held on Friday the 28th of August 1936, at 5 P.M. in the Chemistry Lecture Theatre, University College of Science, 92, Upper Circular Road, Calcutta, with Prof. Dr. B. B. Dey in the Chair, the following gentlemen were admitted as Fellows, their subscriptions having been received for the first time:

G. P. Pendse, Esq., M.Sc. (Gwalior); Dr. Surendra Nath Ray, M.Sc., Ph.D. (Calcutta); Kalipatnapu Kondaiah, Esq., M.Sc. (Benares); S. Raju, Esq., M.Sc. (Benares); Prof. Satyendra Nath Bose, M.A. (Dacca); Dr. Lavji Thoria, Dr. Ing. (Bombay); Akundi Jogarao, Esq., M.Sc. (Benares); Sarju Prasad, Esq., M.A., M.Sc. (Benares); G. R. Phansalkar, Esq., M.Sc. (Benares); Dhirendra Nath Majumdar, Esq., M.Sc., A.I.I.Sc. (Benares).

The following gentlemen were elected as Fellows by ballot, Dr. K. N. Bagchi and Dr. P. C. Mitter acting as scrutators:

Gyanendra Nath Banerjee, Esq. (Bombay); Mahadeo Ganesh Kale, Esq., M.A. (Bombay); Nirmalendu Nath Ray, Esq., M.Sc. (Rajshahi); Nadiabehari Adhikari, Esq., M.Sc. (Calcutta); H. Ramaswamy Iyengar, Esq. (Mysore); S. Venkata Rao, Esq., M.Sc. (Bangalore); Dr. K. S. Nargund, M.Sc., Ph.D. (Ahmedabad); P. D. Swami, Esq., B.Sc. Visharad, (Benares); Dr. Pulin Behari Sarkar, D.Sc. (Calcutta); Baradananda Chatterjee, Esq., M.Sc. (Calcutta); Narayan Chandra Sen-Gupta, Esq. (Calcutta).

Prof. Dr. J. C. Ghosh delivered a lecture on "Recent Work on the Oxidation-Reduction Potential of Systems of Biological Interest". Dr. B. B. Dey, Dr. B. C. Guha and Dr. J. N. Mukherjee took part in the discussion.

* * *

The Principal Rots of English Oak.—(His Majesty's Stationery Office. Price 2*s.* net. Post Free 2*s.* 3*d.*)—"The Principal Rots of English Oak" provides a concise survey of existing knowledge and of recent work carried out at the Forest Products Research Laboratory on the subject of decay in this timber. Adequate keys and descriptions are given which facilitate the recognition of the different rots and fungi concerned. These together with information on the economic aspects of the various rots, and in

some cases on control measures, as well as physiological and cultural data, make this handbook a very useful work of reference both to those who handle or use the timber on a large scale and to students of forestry and botany.

* * *

It is learnt that the Royal Society, London, have approved plans for medical research on malaria and nutrition in India. It is estimated that the total expenditure for the next five years amounts to £ 8,000. Col. Sinton will investigate certain aspects of malaria with the help of the London School of Hygiene and Tropical Medicine; a study of mosquitoes in the tropics will be made. Dr. C. Wilson will undertake a survey of nutritional conditions in India.

* * *

A prize of Rs. 100 (announced by the *Indian Journal of Venereal Diseases*) was awarded to Dr. D. V. Subba Reddi, M.B.B.S., Medical Registrar, Medical College, Vizagapatam, for the best original thesis on 'Antiquity of Syphilis (Venereal Diseases) in India'. The thesis was judged by a committee consisting of: Lt.-Col. K. K. Chattarjee, Dr. R. V. Rajam, Lt.-Col. Jelal M. Shah, Dr. P. V. Gharpure and Dr. U. B. Narayanrao. The thesis is now printed in a book form and can be obtained from the Office of the Indian Journal of Venereal Diseases.

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Dr. Harendranath Ray, M.Sc., Ph.D., postgraduate lecturer in Zoology, University of Calcutta, has been appointed Protozoologist, Imperial Institute of Veterinary Research, Muktesar.

* * *

Flexible High Vacuum Seals.—In the studies involving high vacuum technique, tight, nongassing connections are necessary between the pump and the gauge or between the pump and the system being exhausted, which could be quickly made and quickly removed. The use of glass seals is out of question because of the frequency with which they have to be made and broken. Further the connection to the pump is always a glass to metal connection. Recently this problem has been solved by a new preparation called the *Cenco Seal*. The seal can be applied to metal-to-metal, metal-to-glass, or glass-to-glass joints. It requires that the outside diameters of the connecting tubes be about equal, and that their ends be cut off reasonably 'square'. The two tubes are brought in abutment. The joint between them is surrounded by a strip of thin metal, like aluminium, closely fitting but ends not overlapping. The purpose of this collar is two-fold—to prevent exposure of rubber surface to the vacuum and to prevent atmospheric pressure from causing intrusion of the rubber into the system. Several strips of the cohesive rubber tape are then wrapped around the joint, for a distance of a few centimetres on each side of the collar. The tape thus wrapped forms a homogeneous sleeve of soft rubber about the joint, which perfectly seals it. If the joint is to be semi-permanent, a coating of shellac may be applied over the rubber. To 'take down' a Cenco Seal, the rubber is cut with a safety razor blade.

The tape is supplied by Central Scientific Co., 460, East Ohio Street, Chicago, in strips separated by non-sticking sheets. Once its surfaces are pressed together, they cohere and cannot be separated.

* * *

The discovery that *ephebogenesis*—reproduction with only male cells present—is perfectly possible in nature has recently been demonstrated by Dr. E. Newton Harvey, Princeton biologist. Parts of the eggs of sea urchins which contained no female nuclei were found to be capable of development by whirling into living organisms in a new centrifuge microscope developed in the laboratories of *Bausch & Lomb Optical Co.*

This "cell carrousel" is a streamlined rotor mounted on the shaft of a fast electric motor. Inside the rotor an ingenious system of microscope optics and prisms has been built to reflect light up into the eyepiece. At 10,000 revolutions per minute the light impulses reaching the eye are of the order of 1/300,000 of one second, but repeated 10,000 times a minute the impulses give the impression of a continuous image.

The force developed by this centrifuge is 12,000 times gravity. As the cell is whirled, the molecular particles are separated according to their specific gravity.

The action on the cell results in an acceleration of the process of sedimentation. While the principle of the centrifuge is not new, a microscope connected with it to observe the specimen and for recording the process of disintegration photographically is of the greatest interest to biologists and physiologists. Dr. Harvey, in his experiments on the egg of the sea urchin, *Arbacia*, has shown how the cell stretches and ultimately divides into halves, each half having life.

The molecular weight of extremely minute particles may be determined by measuring the speed at which they travel through a fluid for a known centrifugal force. The minute unicellular organism, *Paramecium*, may be weighed by finding the exact point at which it fails to swim against a definite centrifugal force. This tiny organism, 0.25 mm. long, with a weight of 0.000175 mg., can lift nine times its own weight.

Many processes of industry and puzzles of medicine and biology are at present hidden in the still unknown structure of the cell and of the large protein molecules, such as those of silk, rubber, rayon and wood.

A demonstration of the Harvey-Loomis centrifuge microscope was recently given before a distinguished group of scientists on July 20, at the opening of Bausch & Lomb's new offices, 35th Floor, R. C. A. Building, Rockfeller Center, New York City.

* * *

Announcements.

Indian Science Congress Association.—It has been proposed that discussions and symposia on the following subjects may be arranged at the next Session of the Indian Science Congress Association to be held at Hyderabad in January, 1937, provided the proposal receives sufficient support. Members of the Science Congress interested in the proposal

are hereby requested to get into touch with the Sectional President whose name is mentioned against the subject for discussion in the following list :—

I. "On Wegener's Theory of Continental Drift as regards India and Adjacent Countries." (Joint Discussion—Geology and Geography, Zoology and Botany Sections.)
Mr. W. D. West, M.A., Geological Survey of India, 27, Chowringhee, Calcutta.

II. "On the Need for a Soil Survey for India." (Joint Discussion—Geology and Geography and Agriculture Sections.)
Mr. W. D. West, M.A., Geological Survey of India, 27, Chowringhee, Calcutta.

III. "The Age of the Deccan Trap." (Geology and Geography Section.)
Mr. W. D. West, M.A., Geological Survey of India, 27, Chowringhee, Calcutta.

IV. "On Nutrition in Relation to Crops as well as Human Beings and Farm Livestock." (Joint Discussion—Medical and Veterinary Research, Physiology, Agriculture and Chemistry Sections.)
Col. A. Olver, F.R.C.V.S., Animal Husbandry Expert, Imperial Council of Agriculture Research, New Delhi.

* * *

Indian Journal of Venereal Diseases.—*Award of Prizes* :—Two prizes, each of the value of Rs. 100, will be awarded for articles on the subjects mentioned below :—

1. 'Serology in the diagnosis and prognosis of Venereal diseases'.
2. 'Investigations into lymphogranuloma inguinale'.

These prizes have been offered to the Journal, the first by the Manwantar Printing Press and the second by an esteemed 'Admirer' of the *Indian Journal of Venereal Diseases* who has preferred to remain anonymous, 'as an humble contribution towards the noble and selfless cause of carrying on an extensive and expensive propaganda by the Journal'. The two prizes are to be awarded to the best article in each of the announced subject.

* * *

The Second International Congress of the International Association for Testing Materials will be held in London in April, 1937, under the presidency of Sir William Bragg. Further information can be had from Mr. K. Headlam-Morley, 28, Victoria Street, London, S. W. 1.

* * *

Applications are invited from science graduates with M.R.C.V.S. diploma for the award of a research scholarship of Rs. 150 per month tenable for two years, for conducting research on a suitable subject in veterinary science at the Imperial Institute of Veterinary Research, Muktesar. The Inter-University Board, India, has recognised the Institute as a centre for post-graduate training leading to the degrees of PH.D. and D.Sc. of Indian Universities. Applications will be received by the Director, Imperial Institute of Veterinary Research, Muktesar, Kumaon P.O., U.P., up to the 12th October 1936.

* * *

Applications are invited for—(1) Medical Officer for Health, Gadag Belgiri Municipal Borough; salary Rs. 200–20/2–300–20–400; apply to President, Gadag Belgiri Municipal Borough, Municipal Office, Gadag. (2) Spinning Master, Technological Research Laboratory, Matunga, Bombay; salary Rs. 500; apply to Secretary, Indian Central Cotton Committee, P. O. Box 10,002. Bombay; last date for application: 30th September 1936. (3) Lecturer in Physics, University College, Rangoon, from November 1, 1936 to March 15, 1937; salary Rs. 400 per month; Apply to Principal, University College, Rangoon; last date for application: October 15, 1936. (4) Registrar of the Bengal Council of Medical Registration and Secretary to State Medical Faculty, Bengal; salary Rs 400–20–500; apply to President, Bengal Council of Medical Registration, 21, Old Court House Street, Calcutta; last date for application: 30th September 1936. (5) Two posts as Superintendents of Farms, salary Rs. 150 to 250 according to qualifications; apply to Economic Adviser, Bhopal.

* * *

We acknowledge with thanks receipt of the following :—

"The Agricultural Gazette of New South Wales," Vol. XLVII, No. 8, August 1936.

"Journal of Agricultural Research," Vol. 52, No. 12, and Index to Vol. 51.

"Indian Journal of Agricultural Science," Vol. VI, No. 3, June 1936.

"Monthly Bulletin of Agricultural Science and Practice," Vol. 27, No. 7, July 1936.

Dominion of Canada, Department of Agriculture :—Publication No. 478: "Lamb Feeding in Southern Alberta with a Supplement on the Utilisation of the Forest Reserve for Summer Sheep Pasture"; Pub. No. 483: "The Potato in Canada"; Pub. No. 487: "Trends in the Canadian Tobacco Industry 1920–1934"; Pub. No. 502: "Skin Scabies or Mange of the Fox," by P. J. G. Plummer: Pub. No. 505: "Insects Attacking the Potato"; Pub. No. 507: "Package Bees and how to install them"; Pub. No. 511: "Goose Raising".

"Journal of Agriculture and Livestock in India," Vol. VI, Part IV, July 1936.

"The Philippine Agriculturist," Vol. XXIV, No. 3, August 1936.

"The Allahabad Farmer," Vol. X, No. 4, July 1936.

"Journal of the Royal Society of Arts," Vol. LXXXIV, Nos. 4365–4369.

"The Biochemical Journal," Vol. 30, Nos. 6 and 7, June and July 1936.

"Journal of the Indian Botanical Society," Vol. 15, No. 4, August 1936.

"Communication from the Boyce Thomson Institute," Vol. 8, No. 2, April-June 1936.

"Journal of the Institute of Brewing," Vol. XLII, No. 8, August 1936.

"The Calcutta Review," Vol. 60, No. 3, September 1936.

"Carnegie Institute of Washington—New Service Bulletins," Vol. IV, No. 6, "Important Maya Discovery in the Guatemalan Highlands".

"Chemical Age," Vol. 35, Nos. 890–894.

"Journal of Chemical Physics," Vol. 4, No. 8, August 1936.

"Journal of the Indian Chemical Society," Vol. 13, Nos. 6 and 7, June and July 1936, and Index to Vol. 12, 1935.

"Berichte der Deutschen Chemischen Gesellschaft," Vol. 69, No. 8.

"Transactions of the Faraday Society," Vol. 32, Part 8, August 1936.

"Indian Forester," Vol. LXII, No. 9, September 1936.

"Indian Forest Records," Vol. II, No. 3, Silviculture :—"A Stand Table for Chir (*Pinus longifolia*, Roxb.)."

Vol. I, No. 1, Silviculture : "A Preliminary Survey of the Forest types of India and Burma."

Vol. II, Nos. 2 and 3, Entomology : "Immature Stages of Indian Coleoptera (19)"; "Entomological Investigations on the Spike-disease of Sandal."

Vol. II, No. 4, Entomology : "New Indian Cerambycidæ," by J. C. M. Gardner.

"Forschungen und Fortschritte," Vol. 12, Nos. 22–24.

Government of India Publications :—

"Monthly Statistics of Production of Certain Selected Industries of India" (Department of Commercial Intelligence and Statistics), Nos. 1 and 2 of 1936–37, April and May 1936.

Indian Meteorological Departments, Vol. VI, No. 68 : "Hourly Rainfall at Lahore," Vol. VII, No. 69, "A Statistical Analysis of the Distribution of the South-West Monsoon Rainfall at Akola".

"Indian Trade Journal," Vol. CXXII, Nos. 1573–1576.

"Memoirs of the Geological Survey of India," Vol. LXX, Part I. "An Attempt at the Correlation of the Ancient Schistose Formations of Peninsular India," by Sir L. L. Fermor, 1936.

"Quarterly Bulletin of the Health Organisation," Vol. V, No. 2, June 1936.

League of Nations—"The Problem of Nutrition : Vol. I, Interim Report of the Mixed Committee on the Problem of Nutrition." Vol. III, "Nutrition in Various Countries."

"Medico-Surgical Suggestions," Vol. 5, No. 7, July 1936.

"Mathematics Student," Vol. IV, No. 1, March 1936.

"The Micro," No. 4, July 1936. (Post Office Journal of Ceylon.)

"Geological, Mining and Metallurgical Society of India"—Annual Report for the Session 1935–36.

"Nature," Vol. 138, Nos. 3483–3485.

"Indian Journal of Physics and Proceedings of the Indian Association for the Cultivation of Science," Vol. X/(XIX), Part IV.

"Ceylon Journal of Science," Vol. IV, Part II, Medical Science ; Vol. XX, Part I, Zoology and Geology : *Spolia zylanica*" and Index to Vol. XIX.

"Science and Culture," Vol. II, No. 3, Sept. 1936, and Index to Vol. I.

"Science Forum," Vol. I, No. 6, August 1936.

"Lingnan Science Journal," Vol. 15, No. 3, July 1936.

"Indian Journal of Veterinary Science and Animal Husbandry," Vol. VI, Part II, June 1936.

Catalogues:

"Photo-Micrographic Equipment" (Messrs. Bausch and Lomb Optical Co., Rochester, N. Y.).

"Scientific and Technical Books," June 1936 (Messrs. Edward Arnold & Co.).

"Monthly List of Books on Natural History and Science," August 1936 (Messrs. Wheldon & Wesley, London).

ACADEMIES AND SOCIETIES.

Indian Academy of Sciences:

August 1936. SECTION A.—GURDAS RAM AND V. I. VAIDHIANATHAN : *Uplift Pressure and Design of Weirs with Two Sheet Piles.*—As the toe of a Weir is its vulnerable point, Weir design must commence from the downstream end, so as to control the exit gradient. T. R. SESHADRI AND P. SURYAPRAKASA RAO : *Geometrical Inversion in the Acids derived from the Coumarins. Part III.* Trans to Cis.—Heating with mercuric chloride in neutral aqueous solution has been found to be very satisfactory. T. R. SESHADRI AND P. SURYAPRAKASA RAO : *Reactivity of the Double Bond in Coumarins and Related α-β Unsaturated Carbonyl Compounds. Part II.—Reaction of Mercury Salts on Coumarins.*—It is established that mercuric acetate reacts with the double bond in the coumarins studied and further mercurates the benzene ring in positions 6 and 8 if they should be free. Mercuric chloride does not react with 6-nitro-coumarin. I. CHOWLA : *On Sums of Powers.* S. CHOWLA : *Note on Waring's Problem.* C. S. VENKATESWARAN : *Polarisation of Raman Lines in Some Inorganic Acids.*—Nitric, iodic, sulphuric, selenic and selenious acids have been investigated, and their structural formulas discussed in detail. S. RAMACHANDRA RAO : *Magnetism and Cold Working in Metals. Part II.—Single Crystals of Bismuth, Zinc and Tin.*—Single crystals of Bismuth, Zinc and Tin were prepared by the method of slow cooling and the influence of cold working on the principal susceptibilities was investigated. R. ANANTHAKRISHNAN : *The Raman Spectra of Tri-Methyl-Amine and Some Compounds of Hydroxylamine and Hydrazine.*—The proper assignment of the Raman lines and the constitution of the salts have been discussed in detail with aid of polarisation data. S. PARTHASARATHY: *Ultrasonic Velocities in Organic Liquids. Part VI.—Related Compounds.* H. GUPTA : *Decomposition into Cubes of Primes (II).* N. S. NAGENDRA NATH : *The Diffraction of Light by High Frequency Sound Waves : Generalised Theory. The Asymmetry of the Diffraction Phenomena at Oblique Incidence.*—A solution is attempted of the

difference-differential equation in Raman and Nath's papers IV and V. The idea of 'propagation' of light in a quasi-homogeneous medium is fundamental and preferable to the undefined idea 'reflection' in such a medium. P. K. RAMAN: *Studies in Atmospheric Radiation. A Discussion of Some Observations of Nocturnal Radiation made at Poona and Sinhagad.*

August 1936. SECTION B.—T. R. BHASKARAN: *Studies on the Mechanism of Biological Nitrogen Fixation. Part III.—Economy of Carbon during Fixation of Nitrogen by* Azotobacter chroococcum *Beij.*—The mechanism of nitrogen fixation in soil is different from that by Azotobacter alone in pure cultures. BAHADUR SINGH: *The Life-History of* Ranunculus sceleratus *Linn.*—The morphology of *Ranunculus sceleratus*, the most primitive species of the genus, has been reported. MAKUND BEHARI LAL: *A New Species of the Genus* Levinseniella *from the Jack Snipe,* Gallinago gallinula. M. S. RANDHAWA: *Contributions to Our Knowledge of the Freshwater Algæ of Northern India. I.—Oedogoniales.* JEHANGIR FARDUNJI DASTUR: *A Nematode Disease of Rice in the Central Provinces.*—A new disease caused by a nematode of the genus *Aphelenchoides* is described. C. R. HARIHARA IYER AND R. RAJAGOPALAN: *Estimation of Nitrogen by Fumeless Digestion. Part III.—Extension of Chromo-Sulphuric Acid Digestion to include Large Quantities of Nitrates.* B. M. JOHRI: *Studies in the Family Alismaceæ IV.* Alisma plantago *L.*; Alisma plantago-aquatica *L. and* Sagittaria graminæ *Mich.*—An account of the embryo sac of 3 plants of the family Alismaceæ is given. B. M. JOHRI: *The Life-History of* Butomopsis lanceolata *Kunth.*—From the embryological point of view, there is a close affinity between the *Alismaceæ* and *Butomaceæ* and their separation into two different orders is unnecessary. T. R. BHASKARAN AND V. SUBRAHMANYAN: *Studies on the Mechanism of Biological Nitrogen Fixation. Part IV.—Nitrogen Fixation by the Mixed Microflora of the Soil in Presence of the Acid Products of Anærobic Decomposition of Carbohydrates.* NUGGEHALLI KESHAV IYENGAR AND MOTNAHALLI SREENIVASAYA: *Studies on Inulinase.*—Highly active preparations of inulinase can be obtained from a species of *aspergillus* grown on artichoke nutrient media. A definite relationship exists between the phosphorus content of the preparation and its inulinase activity.

Indian Chemical Society:

June 1936.—O. N. KUMARASWAMY AND B. L. MANJUNATH: *Chemical Examination of the Fixed Oil from the Seeds of* Celastrus Paniculatus, *Willd.* R. C. SHAH AND P. R. MEHTA: *C-Alkyl Resorcinols. Part II.—Synthesis of Poly-Alkyl Resorcinols.* JNANENDRA NATH MUKHERJEE, SUBODH GOBINDA CHAUDHURY AND KRISHNADHAN BHABAK: *Variation of the Cataphoretic Velocity of Colloidal Particles during Aggregation—Part I.* B. B. DEY, S. RENGACHARI AND M. V. SITHARAMAN: *Peroxidases. Part III.—A Potentiometric Method of Estimating their Activity.* PANCHANAN NEOGI AND SARAJIT KUMAR NANDI: *New Compounds of Gallium—Part I.* K. V. BOKIL: *Oxidation of Acetyltetrahydroquinoline Sulphonic Acids.* SATYAPRASAD ROY-CHOUDHURY, SARAJIT KUMAR NANDI AND JIBAN KRISHNA BANERJEE: *On Activated Charcoal. Part II.—Purification by Washing with Water and by Activation.* S. K. RANGANATHAN: *A Synthesis of* cis- *and* trans-dl-iso *Propylcyclopropane-1: 2-dicarboxylic acid and experiments towards the Resolution of* cis-dl-*acid.*

July 1936.—P. C. RAY AND ANIL CHANDRA RAY: *On the fluorination of organic compounds. Part II.* JNANENDRA NATH MUKHERJEE, SUBODH GOBINDA CHAUDHURY AND JYOTIRMOY SEN-GUPTA: *Variation of cataphoretic velocity of Colloidal particles during Aggregation.* SHRIDHAR SARVOTTAM, JOSHI AND SADASHIV S. KULKARNI: *Studies in the coagulation of colloids. Part XIV. Coagulation of colloid arsenious sulphide by mercuric chloride. Inadmissibility of viscosity and transparency as general criteria of coagulation.* P. C. MITTER AND (MISS) TANIMA SEN-GUPTA: *Studies in the Anthraquinone Series—Attempts to synthesise anthraquinone carboxylic acids of the Morindone type.* B. N. GHOSH: *The Enzymes in Snake venom. Part I.—Their Action on Hæmoglobin and on Protein Solutions of Different pH.* SUSIL KUMAR RAY AND RAMA RANJAN BHATTACHARYA: *On the Study of Polyhalides. Part IV.—Formation and Dissociation of Polyhalides of Ammonium and Substituted Ammonium Bases.* M. GOSWAMI AND A. SHAHA: *Attempts to prepare ring glycerides. Preparation of tetrachlorodiglycerides of dicarboxylic acids.* MOHAN SINGH: *The rotatory powers of substituted camphoranilic acids.* NARSHINH MULJIBHAI SHAH AND RUPCHAND LILARAM ALIMCHANDANI: *Chloral Derivatives of Salicylic Acid.* NARINDRA NATH CHOPRA AND JNANENDRA NATH RAY: *Methoxy-oxypalmatine.* ANUKUL CHANDRA SIRCAR AND SAILESH CHANDRA SEN: *Studies in the Acenaphthene quinone series. Part II.* SUSIL KUMAR RAY: *Parachor and the structure of formic acid.* SACHINDRA NATH ROY: *A Note on the use of adsorption indicators in acidimetry and alkalimetry.*

Indian Botanical Society:

August 1936.—S. K. PANDE: *Studies in Indian Liverworts:—A Review.* L. P. KHANNA: *On Indian Species of the Genus* Anthoceros *Linn. with a Description of a New Species from Travancore.* P. PARIJA AND K. SAMAL: *Extra-Floral Nectaries in* Tecoma capensis *Lindl.* S. C. VARMA: *Some Ecological Aspects of the Upper Gangetic Flora.*

Calcutta Mathematical Society:

August 16, 1936.—N. N. GHOSH: *On a Class of Determinants having Geometrical Applications.* A. C. CHOWDHURY: *On Reducible Hyperelliptic Integrals.* C. N. SRINIVASIENGAR: *Lines of Striction on the Quadric and on Some Other Scrolls.* S. GHOSH: *Plain Strain in an Infinite Plate with an Elliptic Hole.* M. DE DUFFAHEL: *On a Class of Integral Equations.* A. MÖESSNER: *Simultane Identitaten.*

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Benares Hindu University:

The Inaugural Address of the Scientific Society was delivered on the 6th September by Professor B. Sahni of Lucknow University. The subject of the address was "Early Man in Northern India."

Professor Sahni has been appointed an Honorary Professor of the Benares Hindu University.

Calcutta University:*

Personnel.—Mr. Syamaprasad Mookerjee has been re-appointed Vice-Chancellor of the University.

Mr. A. Macdonald, Principal, Bengal Engineering College, retired from service after a distinguished career in the Education Department, extending over 25 years.

Grants.—The Imperial Council of Agricultural Research has sanctioned a scheme for the investigation of the life-history, bionomics and development of freshwater fishes of Bengal. The investigation will be carried out under the direction of Prof. H. K. Mookerjee, Professor of Zoology. A grant of Rs. 6,620, extending over a period of 3 years has been provided by the Imperial Council and this is to be supplemented by a non-recurring grant from the Calcutta University.

Courses of Study.—The committee appointed by the Syndicate to consider the question of the inclusion of the pre-medical course for the M.B. Examination in the syllabus for the I.Sc. examination has submitted its report to the Syndicate recommending that the pre-medical course comprised in the preliminary science M.B. examination, be included in a special I.Sc. course to be instituted for the purpose. If the report is adopted, students passing the special I.Sc. examination will be entitled to begin their studies from the second year class of the Medical College and finish their medical course within five years.

Awards.—Mr. Subhendusekhar Basu (Thesis: 'Theory of distribution in statistics and its application') and Mr. Nalinikanta Saha (Theses: 'Studies in the electrical theory of solid metal'; 'On the pressure of electrical resistance in metals') have been elected to the Premchand Roychand studentship in scientific subjects from July 1935.

Srimati Kamala Debi, of the Vidyasagar College, Calcutta, has been awarded the Basanta Gold Medal for 1935, for her thesis on 'Health Education through Schools in Bengal'.

Dr. Sukumar Sarkar, D.Sc., has been awarded the Sir Asutosh Mookerjee Medal for 1935, for his thesis entitled 'The Nature of solid and liquid as revealed by light scattering".

*With acknowledgments to the "Calcutta Review," September, 1936.

University of Madras:

Mr. R. Littlehailes, Vice-Chancellor, who was on leave from the 5th June, returned on Saturday, the 29th August, and joined duty the same day (afternoon).

Two Convocations of the University were held in August 1936—the first one on the 28th August was held for candidates taking second degrees—M.A., L.T., B.L., at which the Vice-Chancellor (Dr. A. Lakshmanaswami Mudaliyar) presided—512 graduates took their degrees; the Second Convocation was held on the 29th August 1936 at which H. E. the Chancellor, Sir Kurma Venkata Reddi (Ag. Governor of Madras), presided. About 1,500 graduates in all the Faculties took their degrees (807 in person and 581 *in absentia*). The address to the Graduates was delivered by Mahamahopadhyaya S. Kuppuswami Sastri, Avl., M.A., I.E.S. (Retd.), now Honorary Professor of Sanskrit, Annamalai University.

The new Buildings of the University—Library, Departmental Building, Botanical Laboratory and Examination Hall — were opened by His Excellency, the Chancellor, on Thursday, the 3rd September 1936.

University of Mysore:

Personnel.—Mr. C. R. Narasimhasastry, M.A., Assistant Professor of Sanskrit, Maharaja's College, Mysore, was appointed Professor of Sanskrit on the retirement of Professor D. Srinivasachar.

Examinations.—The results of the M.A. and M.Sc. degree examinations were published during the month. They were as follows:

Name of Examination	Examined	Passed 1st Class	Passed 2nd Class
M.A.	13	3	9
M.Sc.	12	3	7 + 1 (not classed)

Convocation.—The 19th Annual Convocation for conferring degrees will be held in Mysore on the 29th October 1936, at 9 A.M. Dr. E. P. Metcalfe, D.Sc. (Lond.), F.Inst.P., Vice-Chancellor of this University, has been nominated to deliver the Convocation Address this year.

Lecture.—The D. Appu Rao Extension Lecture for 1935–36 on 'Co-operation' was delivered by Mr. V. Ramdas Pantulu, B.A., B.L., of Madras at Mysore on the 1st August 1936.

Meeting of the Academic Council.—(i) A meeting of the re-constituted Academic Council was held on the 29th August 1936 at which the following have been elected members of the University Council to be re-constituted as from the 1st November 1936 by and from the Academic Council:

1. Mr. B. K. Narayana Rao, B.A., M.B.C.M., L.R.C.P., M.R.C.S., D.P.H., D.O., Principal, Medical School, Bangalore.
2. Dr. A. Subba Rau, B.A., D.Sc. (Lond.), F.R.M.S., Professor of Physiology, Medical College, Mysore.

(ii) At this meeting the Faculties were constituted by the assignment of the members of Academic Council and the appointment of three teachers to each Faculty.

(iii) Among the decisions arrived at, mention may be made of the following:—

1. Credit of work done during the course in respect of the Intermediate examination.
2. Revision of the course of studies in History for the B.A. Honours Degree examination.

General.—Mr. K. V. Srinath, M.Sc., Lecturer in Botany, Intermediate College, Bangalore, has been awarded the Central State Scholarship tenable in Great Britain for higher studies in Botany during the years 1936–39 by the Government of India, and has left for England.

1309-36.—Printed at The Bangalore Press, Bangalore City, by G. Srinivasa Rao, Superintendent, and Published by B. N. Sastri, M.Sc., A.I.C., A.I.I.Sc., for the "Current Science" Board of Editors, Indian Institute of Science, Hebbal Post, Bangalore.

CURRENT SCIENCE

Vol. V] October 1936 [No. 4

Science and Society.

EVER since men began to live in organised society, in which the law of the jungle was replaced by tradition and custom, there has been speculation as to the past and the future of humanity. There have been those who placed the golden age in the dim past and looked upon the successive stages of human history as years of decay and decline; others have visualised changes in society as cyclic in character; but the idea of progress which has dominated recent social thought is a child of the later eighteenth century, and it was the hope of the unlimited progress of humanity, which illumined the age of Reason in the later eighteenth century. Condorcet spoke of a "science of man," but it was left to others like Comte and Spencer to work out in detail a science of society, which has come to be known as Sociology, whose 'laws' gave the earlier dreams of progress a body and a direction. Under the influence of the great changes of the Industrial Revolution, these early students of sociology conceived of humanity as moving towards a state of things in which industrialism would be the dominant note, and peace among mankind and goodwill towards all would prevail.

This progress was not supposed to prevail among all sections of humanity, nor was it continuous; many believed with Leslie Stephen that "Progress is the rare exception; races may remain in the lowest barbarism or their development be arrested at some more advanced stage; actual decay may alternate with progress, and even true progress implies some admixture of decay." The early years of the twentieth century seemed to deepen the note of interrogation, and the check to the industrial progress of some of the European countries, the rise of Japan, and the uneasy stirrings in their age-long sleep of other Eastern nations roused the apprehensions of Europe. Accordingly more than a quarter of a century ago, Mr. Balfour examined the possibilities of decadence among the advanced nations of Europe and the chances of advance into the vanguard of progress by Oriental peoples, who were till then believed to be static. Mr. Balfour ruled out the latter possibility, holding that "progress is with the West; with communities of the European type." He was of opinion that the progressive character of the nations of the West would be supported and reinforced by the social force that had

come into being, "new in magnitude if not in kind, *viz.*, the modern alliance between pure science and industry." We have been told how fruitful that alliance has been by Mr. Keynes in his striking description of the "extraordinary episode in the economic progress of man constituted by the age which came to an end in August 1914."

Science had no doubt done wonders for the economic progress of men, but the same date that closed the epoch of economic munificence also opened a devastating episode in the history of man, in which science armed man with weapons of terrific capacity for destruction. The War in which thousands of millions of capital and millions of human lives were destroyed was followed by a short period of seeming prosperity and settlement. Then came the great Depression, which revealed another aspect of science in relation to society. Mankind has been living since 1929 in the shadow of this great economic catastrophe, lacking employment and food, not because the bounty of nature has been exhausted nor because science has come to a stop in its progressive control of natural forces, but entirely because social organisation has proved itself incapable of adjustment to the new discoveries of science, which, it has been proclaimed on all sides, has placed abundance beyond dreams for the first time within the reach of mankind. Man has stood helpless, hungry and cold, before the plenty that science has produced for him. Coffee has been thrown into the sea, wheat has been burnt in furnaces, and pigs have been slaughtered by the million, and mankind is starving.

More. If science has held out the promise of plenty on a colossal scale, it also has armed man with deadly weapons that threaten destruction on an equally large scale, and while nations have not yet emerged out of the long-drawn out period of economic depression, they are racing madly along the path of armaments and destruction.

It is clear that scientific discoveries have outrun man's mental and moral capacities, and we are yet a long way from the realisation of the dream of Condorcet, of "the human race freed from all its fetters, withdrawn from the empire of chance, as from that of the enemies of progress and walking with firm and assured steps in the way of truth and virtue and happiness." For a double problem is set to humanity by the progress of science: smooth articulation of scientific discovery with the complex machinery of social life, and the use for human advancement, and not for human destruction, of the increased control over nature that science has been placing in our hands.

II.

Sir Josiah Stamp in his massive address before the British Association deals mainly with the first of these two problems. He does not deal with the influence or effect of science upon society, but with the fact of impact of science upon society: he asks "whether the transition has been difficult and distressing, in painful jerks and uprootings, costly, unwilling or unjust; or whether it has been easy, natural and undisturbing." An important line of enquiry, for "the impact of science will be surprising and painful in the one case and smooth and undamaging in the other." There can hardly be any doubt that there is much "avoidable friction in the reception given to scientific discovery", and this is hardly a matter for surprise since "the training of the scientists includes no awareness of the social consequences of their work, and the training of the statesmen and the administrator no preparation for the potentiality of the rapid scientific advance and the drastic adjustment due to it, no prevision of the technical forces which are shaping the society in which they live. The crucial impact is nobody's business." It may be that society stands to gain on the whole by applications of science to social life, but there is a wastage of human skill, of capital, and a tearing up of social ties and injuries to allegiances of place and kin. The credit and the debit sides of the account have to be carefully studied, but "in this neutral field the specialist scientist and the politician are both amateurs. It has to be covered by each extending his studies, and by specialists who treat impact and change as an area of scientific study."

Sir Josiah Stamp is careful to point out that there are two elements in the situation, which go to reduce the adverse effects of the impact of science upon industry and society. One of these he calls the "balance of innovation", and it consists in the fact that work-saving changes are set off by work-creating changes, as when quite new objects of public demands are invented and bring together "released labour and released purchasing power in the most decisive way." A second

is the natural increase of population which is an excellent shock absorber for a community, since the effects of a new invention in increasing production are met by the increased demand of the larger population. Sir Josiah does not fail to draw attention to the declining population in the Western industrial countries, which will result in this safety valve being no longer available in the coming years. When all is said and done, there is need for "some regulation of the rate of change to an optimum point in the net balance between gain and damage, even assuming that the gains to society as a whole from a rapid advance are ample enough to cover a change for consequential damages." "Perhaps birth control for people demands ultimately birth control for their impedimenta."

III.

Is it possible to modify "the nature of man to meet impact"? "If we must have quanta of stages, the question is their optimum length and character, not merely the regulation of industry and innovation in their tempo, but the education of man and society to pulse in the same rhythmic wave-length or harmonic." This leads to a consideration of the value of social sciences, and Sir Josiah comments on the disadvantageous distribution of resources for research between Physical Sciences and Social Sciences: "We have not begun to secure an optimum balance. Additional financial resources should be applied more to the biological and human sciences than to the applied physical sciences, or possibly, if resources are limited, a transfer ought to be made from one to the other. Experimental scientists in the older and so productive fields, look askance at the newer borderline sciences of genetics, eugenics and human heredity, psychology, education and sociology but unless progress is made in these fields which is comparable with the golden ages of discovery in physics and chemistry, we are producing more problems for society than we are solving."

What is the line of investigation in these sciences, and what are the directions of human adjustment, to which our expectations should turn? "There must be optimal lines of change which are scientifically determinable. We have seen in a few years that the human o. social temperament has a much wider range of tolerance than we had supposed," whether we take speed in transport, limit of direct taxation, or variations in women's dress. "One hesitates to say, therefore, that resistances to scientific changes will be primarily in the difficulty of mental and physical adjustments. But there can be little doubt that with the right applications of experimental psychology and adjusted education, the mind of man would be still more adaptable." What is proposed is "not to change the same man in his life-time, but to make a larger difference between father and son." This can be done by modifying the social environment, for "the environment of one generation can produce a lasting result, because it can affect the environment of future generations. Environments, in short, as well as people, have children. Though education and so forth cannot influence new births in the physical world, they can influence them in the world of ideas (Pigou)."

IV.

Change there must be, though should be mastered by man. But where is change taking us, and how far is the control of natural forces placed in the hands of man helping him to raise himself? "The future of man," remarks Professor Julian Huxley, "if it is to be progress and not merely a standstill or a degeneration, must be guided by a deliberate purpose." It is true that the formulation of an agreed purpose for man as a whole will not be easy, because in spite of the wave of internationalism that swept over the world at the close of the Great War, national animosities are simmering, and within each nation, the cleavage between classes has been sufficiently wide to make much needed economic and social reforms within a nation hard if not impossible. Men have been brought up on a code of conduct based on the supreme interests of the individual, and social instincts are not yet sufficiently powerful in the individual members of a community. Therefore it is of great significance that Sir Josiah should suggest that "the whole body of ethics needs to be re-worked in the light of modern corporate relations." It is interesting to recall in this connection that Mr. Keynes prophesied several years ago that there would be great changes in the code of morals because drastic economic changes would vitiate the social value of hitherto cherished virtues like thrift.

The great task before nations at the present time is to realise their interdependence and the utter futility of the belief that

one community or a section of a community can prosper while the other communities or the other sections are in misery. The bounty that modern discovery enables men to obtain from nature may at last enable them to free themselves from the age-long haunting economic problem, and at last engage in the pursuit of higher values of life. Men are assisted in meeting the call upon them only in part when the technical problems of the impact of science upon society are solved. More is wanted, and that is social control of scientific discoveries for the advancement of human values and not for mutual destruction. It is therefore comforting to read that at the same session of the British Association which listened to the learned President's call for a new technique and a new outlook in the application of science to social life, Sir Richard Gregory condemned the use of scientific research and invention for inhuman ends, and advocated the conservation of social and spiritual values with scientific teaching and research while Sir Daniel Hall called upon men of science to join in the fight for freedom, condemning the entrusting of science, which meant power, to "power-mongers".

Professor S. S. Bhatnagar, O.B.E., D.Sc.

WE have great pleasure in offering Professor S. S. Bhatnagar, our cordial welcome and felicitations.

It will be remembered that in recognition of his valuable investigations of basic importance to the petroleum industry, Messrs. Steel Bros. & Co., Ltd., and Attock Oil Company placed at his disposal in 1934 large sums of money for further researches on petroleum and kindred subjects. In a spirit of disinterested devotion, Prof. Bhatnagar handed over this munificent grant to the Punjab University, which was more or less in the nature of a personal gift made to him by Messrs. Miller and Ward. With the fund thus rendered available, the Syndicate of the University proceeded to establish several research scholarships in the newly inaugurated Department of Petroleum Research.

Encouraged by the results obtained from Prof. Bhatnagar's investigations and anxious to carry them forward, Messrs. Steel Brothers invited Prof. Bhatnagar to visit their Head Office in London last summer in order to discuss with him further schemes of research, and as the result of their negotiations, they have agreed to provide him with an unconditional subvention of Rs. 2,50,000 for financing their five-year programme. In making this offer Messrs. Steel Brothers express the hope that the results of Prof. Bhatnagar's researches will be of great benefit to their industry, and of value to general science.

Prof. Bhatnagar's attitude towards these grants aggregating to Rs. 4,00,000 is similar to that of Dr. E. P. E. Roux who was awarded the Osiris Prize of £4,000 for the discovery of the anti-diphtheria serum, and who made over this amount to the Pasteur Institute in Paris.

The principle underlying Sir M. Visvesvaraya's public advocacy of associating the Indian industries with the scientific research departments of universities is practically adopted by the Syndicate of the Punjab University in accepting the grant of Messrs. Steel Brothers and permitting the head of their Chemistry Department to pursue the researches planned by their conjoint deliberations. The success of any industrial enterprise depends not only on advertisement and sales agencies but also on the closest co-operation of science and industry. The representation of scientific interests, such as those secured by Messrs. Steel Brothers, in the furtherance of their industry ensures a large amount of sympathy and friendliness for the technical staff, as also the appreciation of the difficulties involved in the various operations comprising their business enterprise.

Judging by the happy results already achieved, we have not the slightest doubt that the association established by Messrs. Steel Brothers and the Punjab University will prove mutually advantageous. The public spirit and self-abnegation of Prof. Bhatnagar have justly earned for him the great esteem of his colleagues and the gratitude of the country.

Locusts as an International Problem.

By B. P. Uvarov, D.Sc.
(*Imperial Institute of Entomology, London.*)

THE statement that locust swarms recognise no boundaries has become a truism but until recently these vagabond tendencies of locusts served only to accentuate international discord. Reports on locust control published by various governments in most cases refer to the excellent results attained locally and to the futility of local efforts in view of the inactivity of the neighbouring countries. Such statements are sometimes true, but more often they are wholly, or partly, incorrect. In any case, there was often more unity between locust swarms bred in the neighbouring countries, than between their respective government departments, to the obvious advantage of the insect.

The necessity for co-operative action against the common enemy has been, of course, realised, but this co-operation is usually wrongly conceived. It is often argued that a locust invasion affecting several countries can be brought to an end, if only all these countries would agree to adopt vigorous control methods and to see that they are carried out. Painful experience of the last invasion of the African continent has proved beyond doubt that an outbreak, once it has been permitted to develop on a really large scale, is beyond practical possibility of being controlled. This is due to the enormous extent of invaded areas, many of which are sparsely, or not at all, populated. Further, the rate of multiplication of locusts is such that when only a small percentage of swarms of one generation escape destruction, the number of their progeny will be just as great as before, or even greater. The only practical policy at the height of an invasion is to concentrate all the efforts on the defence of standing crops. This defensive policy can be very effective, but it does not contribute to the solution of the problem.

The problem must, obviously, be approached from a different direction. It has been always known that locust outbreaks are not a permanent phenomenon, but there is a certain irregular periodicity in their development. Moreover, they always arise first in somewhat restricted areas and only gradually the swarms spread over whole countries and continents. These two points suggest that it should be possible to prevent widespread invasions by concentrating the early efforts in the areas which can be regarded as original sources of the swarms. This conception remained on a purely theoretical basis until recently when the advances made in the study of locust biology and of the factors governing outbreaks have provided a firm foundation for formulating a practical policy of the prevention of locust outbreaks.

The fact of primary importance in this connection was the discovery of the phase variation in locusts. This phenomenon consists in the ability of locusts to develop in two forms, or phases, the solitary and the gregarious, which differ widely in their colouration, structure, physiological reactions and therefore, habits. A thorough experimental study of phase variation commenced only quite recently, but there has already accumulated a considerable amount of information on them, which it would be out of place to review here. It is sufficient to say that the majority of workers on the problem agree that the gregarious phase can be produced in any locust by breeding the larvæ in a dense crowd, *i.e.*, the density of population within a restricted area is the factor causing the transformation. The result of this transformation is a compact swarm of gregarious locusts differing from the original solitary ones in greater rate of activity and in the striking tendency to remain in close proximity to each other which ensures the existence of a swarm as a single unit.

If it is not difficult to obtain any desired density of the initial locust population in experimental cages, the question arises how can a crowding occur under natural conditions in the field. Suggestions have been made that a natural population of solitary locusts may become sufficiently dense to start the transformation merely as a result of a general increase in the numbers of locusts. Such a phenomenon,

however, has never been observed, while, on the other hand, definite observations have been made on the mechanism of phase transformation in the field under somewhat peculiar conditions. It has been found, that the initial concentrations of solitary locusts may, and do, occur as a result of seasonal fluctuations in the extent of favourable habitats. It is well known that locusts, like all other Acrididæ, are highly selective with regard to the type of vegetation. The result is often a patchy distribution, the locusts occurring only in small areas with favoured vegetation. If we imagine, for example, a vast desert area with scattered depressions where grasses grow, these depressions will harbour locusts, while none will be found in the intervening desert. The extent of such grassy areas would increase in years with good rains, and their locust population will also increase. If this favourable period is followed by a year of poor rains, the areas available for locusts will decrease at once, and they will become crowded in the depressions as if they were in cages. A transformation into the gregarious phase will inevitably follow, and the resulting swarms will migrate far and wide, reaching without difficulty the regions suitable for reproduction.

This is a theoretical scheme merely because it is generalised, but it is based on actual observations on the Desert Locust (*Schistocerca gregaria*, Forsk.) and on the Madagascar Migratory Locust (*Locusta migratoria capito*, Sauss.). Studies on the ecology of other locusts suggest that the process of transformation into the gregarious phase is always caused by the instability of their habitats when the latter are not continuous but patchy. It is, therefore, only a matter of intensive ecological research to discover the preferred habitats and the causes of fluctuations in their extent in each particular case.

Such research should, of course, always cover the whole distribution area of a particular locust species, and it would be futile to restrict it to a single country. Moreover, although the so-called outbreak areas, *i.e.*, localities where the initial transformation into the gregarious phase can occur, may be found in one country, the swarms produced there will eventually spread beyond its limits. Therefore, all countries subject to invasions by the particular locust have an immediate interest in the discovery of outbreak areas, and the investigations directed to that end should be organised internationally.

This principle has been actually adopted in the recent investigations organised in Africa by a number of governments interested in the locust problem. It was at once realised that some centralisation of research would contribute greatly to the success of the work and the participating governments agreed that the Imperial Institute of Entomology in London should act as the International Centre for Anti-Locust Research. The first important function of the Centre was to organise a regular collection of the information on breeding and movements of locusts over the whole territory of Africa and Western Asia. A system of monthly reports was organised and every country regularly submits such reports accompanied by maps. These local reports are summarised and monthly maps for the whole invaded area are prepared, so that the development of the outbreak can be followed step by step. As a result of this system, it became possible to reconstruct the whole history of outbreaks of three locust species, and to obtain general indications as to the probable original sources where the outbreak of each of them arose.

These general indications served as a starting point for field ecological research by special entomologists. Detailed plans for the field investigations prepared in each country are discussed at periodical International Locust Conferences, so that the work is distributed according to the possibilities of each country, and no overlapping occurs. The results are also reported to the Conference, while the field investigators keep in touch with the International Centre during their work, and are informed of any developments occurring in other countries. The functions of the International Centre include regular bibliographical work, so that anything published on locusts is brought to the notice of field workers. Advice on various points connected with the study of locusts is also supplied by the Centre, both to field entomologists, and to the already numerous workers in universities, etc., who take locusts as the objects for their researches.

Perhaps, the most interesting feature this international organisation is that

came about without complicated diplomatic agreements, simply as a result of a soundly conceived policy, which received a willing support from all the governments concerned with the locust problem.

The results already achieved by the international organisation can be described as exceeding expectations. Indeed, with regard to one of the locust species under investigation, the African Migratory Locust, (*Locusta migratoria migratorioides*, Rch. & Frm.), it has been definitely proved that its recent invasion of the greater part of the African continent originated in a single area on the Middle Niger in the French Sudan. Practical schemes for establishing the permanent control of that area are now being prepared and it can be hoped that they will be effective in the prevention of future invasions.

Another locust of exceptional importance in Africa is the Red Locust (*Nomadacris septemfasciata* Serville), and three of its outbreak areas have already been discovered, and will be taken under control. Investigations are continuing to find other possible sources of outbreaks.

With regard to the Desert Locust, the invasion of which covers a great part of Africa and most of Western Asia, some good practical results have also been obtained. It has been found that outbreak areas of this species are found not in inner deserts, but on desert sea-coasts where peculiarly unstable ecological conditions are often favourable for the formation of the gregarious phase. Some of the outbreak areas have been definitely located on the coasts of the Red Sea in the Sudan and Arabia, and Indian entomologists have succeeded in defining potential outbreak areas on the Mekran Coast. However, there still remain extensive coastal tracts in Iran, Eastern Arabia, Eritrea and Mauretania where field investigations are either in progress, or should be carried out shortly, if a guarantee against future invasions is to be reached.

This, necessarily very brief, account of the international anti-locust work should be sufficient to show that at least some hope can be entertained for a permanent solution of the locust problem. This has been achieved by unselfish co-operation of several countries, by a carefully planned general scheme of investigations and by centralisation of all the information on the problem in a single, internationally recognised, central institution working for the common benefit. It would not be an exaggeration to say that the international anti-locust research may be regarded as a unique example of determined international effort towards the solution of one of the greatest entomological problems. Whether this effort will be crowned with ultimate practical success, depends entirely on the continued international unity in dealing with the problem even when it will lose its present acuteness. The governments were induced to adopt a far-reaching anti-locust policy because of great economic losses caused by the last outbreak. When the outbreak subsides, there is danger that at least some of the governments may consider it more economical to do nothing and hope for the best. Should this happen, the whole carefully planned anti-locust scheme will be threatened with a collapse and the money and energy spent during the last few years will be largely wasted. The occurrence of another outbreak is only a question of time unless the present policy of prevention is rigorously carried to its logical end.

REFERENCES.

"Proceedings of the Third International Locust Conference, London, September 18, 1934."H.M.S.O., London, Cmd. 4725: (1934), pp. 184, 2 maps, 4 pls.

Maxwell-Darling, R. C., "The Outbreak Centres of *Schistocerca gregaria*, Forsk., on the Red Sea Coast of the Sudan", *Bull. ent. Res.*, **27**, pt. 1, pp. 37-70, 6 figs., 2 pls., 3 refs., London, February, 1936.

Ramchandra Rao, Y., "Mekran—possibly the country of origin of the great locust invasion of Sind in 1926," *Ind. J. Agric. Sci.*, 1933, **3**, 833-846, 2 pls., 2 maps.

Zolotarevsky, B. N., "Contribution à l'étude biologique du criquet migrateur (*Locusta migratoria capito* Sauss.) dans les foyers permanents.—Thèse presentée à la Faculté des Sciences de l'Université de Paris" (A), **260**, pp. 96, 1 pl., 1 map, 13 graphs, 28 tabl.

Enzymes in Relation to Cancer.

By Dr. Ing. Arnulf Purr.

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WARBURG'S researches[1] have shown that the question of the character of malignant growths is primarily a metabolic problem. A consideration of the established facts lead to the conclusion that metabolic processes of the cancer cells bear a significant relationship to the total metabolism of the healthy organs closely. Future research should consequently be directed to discover the functional differences between the metabolism of the entire tumour organism, and that of the healthy organism, with a view to elucidate the causes of the pathological behaviour of the cancer cells.

Since the course and intensity of the metabolic activity in the tumour and in the tumour afflicted organism, is intimately bound up with the enzymatic processes, it is obvious that for understanding the character of the malignant growth, it is essential to obtain a clear knowledge of the various types of enzymes and the mechanism of their activations. The results of experiments carried out on various proteolytic enzymes, described here, are intended to act as a guide for further experiments in the same direction.

The intracellular proteolytic enzymes were studied in the tumours—carcinome and sarcome, produced experimentally, and in the organs of cancerous and healthy animals. The pathological-anatomical analysis and the fixation of their proportions in the total substance, served as a basis for the comparison of the growth-changes in the histologically differing elements of the tumour-tissue.* Of the enzymes examined, cathepsin shows a significant decrease with the ageing of the tumours (increase in the necrotic tissue) (*cf.* Fig. 1). One can consequently conclude that this enzyme is confined almost exclusively to the parenchymatous tissue. The arginase, on the other hand, behaves differently; the quantity increases considerably as necrosis proceeds. It appears, that the arginase is to be found principally in the necrotic tissues and only to a small extent in the growing tissues. These facts, which were established by Waldschmidt-Leitz, McDonald and collaborators[2] (1933) led the author to investigate

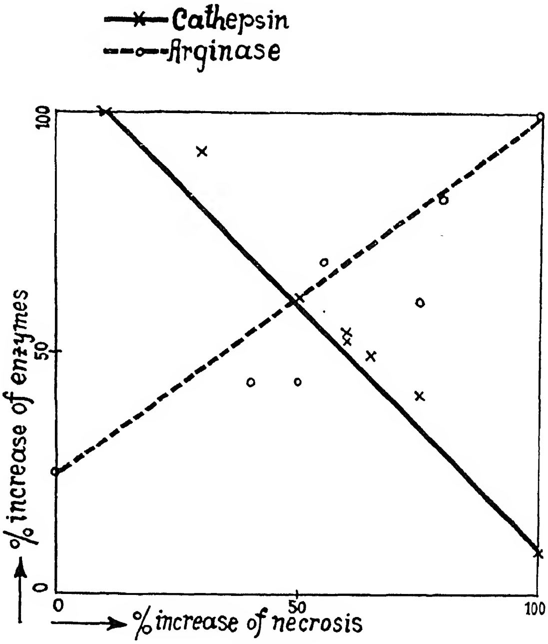

Fig. 1.

further, the general distribution of the enzymic systems in cancerous and healthy animal tissues. In the first instance, attention was directed to the study of the enzymic contents in the organs of healthy, cancerous and cancer-immune animals.

Cathepsin studies with albino rats showed (A. Purr, 1934)[3] that in healthy albino rats (ordinary untreated laboratory rats) the cathepsin content of the liver (measured as full-activity with cysteine as activator) was uniform; the muscle-tissue was found to be practically free from these enzymes. Changes, worthy of note, occur only after these rats have been successfully inoculated

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[1] O. Warburg, *On the Metabolism of Tumours.* J. Springer, Berlin, 1926.

* We distinguish between parenchymatous, fibrous and necrotic proportional parts.

[2] E. Waldschmidt-Leitz, E. McDonald and collaborators, *Z. Physiol. Chem.*, 1933, **219**, 115.

[3] A. Purr, *Biochemie J.*, 1934, **28**, 1907.

with transplantable rat—sarcome Philadelphia I; the cathepsin content of the liver increases considerably and the muscle-tissue exhibits appreciable catheptic activity. It should be noted that the increases of the catheptic enzyme concentration in the liver and the muscle-tissue do not run parallel with the decrease of the same in the ageing cancerous tissue as measured by the increase of the necrotic cells); on the contrary all indications point to the fact that there is a disturbance in the enzymatic metabolism. Edelbacher and Merz[4] were able to establish a similar behaviour in arginase, proving that the presence of this enzyme was to be found in the muscle-tissue of animals which had been successfully inoculated with transplantable cancer; they found however no arginase in the muscle-tissue of normal, healthy animals. It may be concluded, therefore, that the increase in the quantity of arginase points to a specific factor of growth, which like the disturbed glycolysis (known through the research work of Warburg[1]) is characteristic of a malignant growth; the increased catheptic activity in the liver and muscle-tissue is also a characteristic sign of a specific growth-factor. A further noteworthy observation may be mentioned in this connection; the albino rats that had successfully resisted the inoculated tumour had from the very beginning more cathepsin in the liver and in the muscle-tissue than the ordinary untreated laboratory rats. Similar experiments on the kidney-phosphatase of cancer-resistant rats led F. Kohler[5] to analogous results. It appears therefore that a higher but well regulated enzymic metabolism is characteristic of cancer-immune organisms. These important observations indicate a successful biochemical method of diagnosing cancer in its incipient stages, a so-called early diagnosis.

For a proper understanding of the change of the enzymatic metabolic processes in the tumour cells in relation to the organisms which are resistant against inoculation, the study of the activation phenomena for the individual enzymes is important, not only as regards their characterisation but also as regards their collective and individual disturbance within the organism as a whole. Such studies should prove particularly valuable for purposes of early diagnosis. The study of these activat n changes, carried out on the intercellular proteolytic enzymes cathespin and papain, required a number of preliminary tests,[6] to which special attention should be drawn since they led to the standardisation of a method for the determination of physiologically active substances in the blood,[7] the application of which rendered possible a comparison between the intracellular metabolism of healthy and cancerous organs. As a measure of the concentration of such active principles, the activation of papain brought about by SH-groups has been adopted (*cf.* Fig. 2).

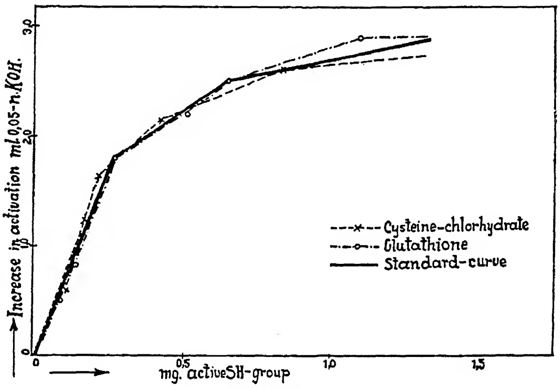

Fig. 2.

The progress of the activation of papain through cysteine hydrochloride or possibly glutathione has proved useful in estimating the latter substance on the basis of the SH-group (*cf.* Fig. 3). The employment

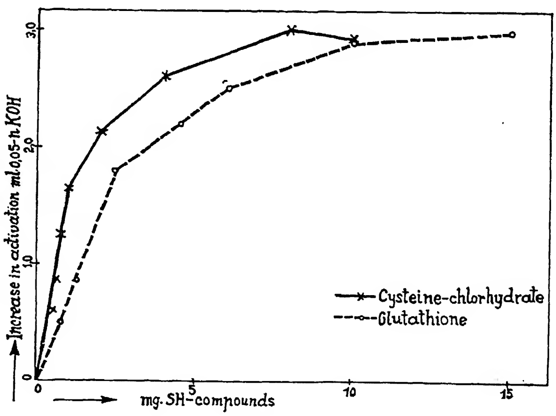

Fig. 3.

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[4] Edelbacher and Merz, *Z. Physiol. Chem.*, 1927, **171**, 252.

[5] F. Kohler, *Z. Physiol. Chem.*, 1934, **223**, 38.

[6] A. Purr, *Biochem. J.*, 1935, **29**, 5-20.

[7] A. Purr, *Z. Physiol. Chem.*, 1934, **228**, 198.

of this procedure for comparing the activating effects produced on the papain by blood from healthy and from cancerous organisms, showed that the blood from the latter possessed a lower activating capacity than the blood from healthy organisms (*cf.* Fig. 4).

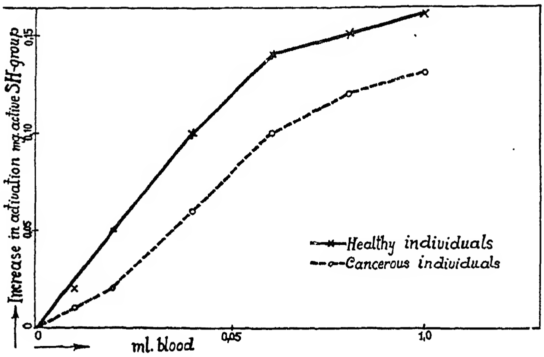

Fig. 4.

A most striking point in the result of this experiment and one worthy of particular note is that the glutathione present in the blood can only participate to a slight extent in the total capacity of activation of papain; for, the activating effect does not correspond quantitatively to the amount of glutathione found in the blood. Consequently the greater part of the activation must have been produced by auxiliary activating systems present in the blood, a circumstance which facilitates the recognition of such physiologically active systems in the blood.

It is proposed to carry out the experiments on a more extensive scale and the results obtained so far lead to the belief that an early diagnosis of cancer is possible by the study of activation phenomenon.

The differences in the behaviours of the cathepsin and arginase referred to at the commencement of this article, were pointed out by Waldschmidt-Leitz, McDonald and collaborators[2] and was later confirmed by the author[3] working with histologically uniform structural elements of the tumour-tissue. It appears that a young, vigorously proliferating cancer-tissue, free from necrosis, is characterised by a high cathepsin and a low arginase concentration. This is especially true in the case of melanomes in horses (also included in the series of experiments[8]) and on account of its striking behaviour, this material is worthy of further tests.

These findings possessing profound physiological significance lead to the conclusion that in the cancerous cells, the synthesis of the albuminous covering, in which process, cathepsin participates, is delayed. There is no ground for the supposition that in the ageing cancerous tissue the autolytic cell-destruction is related to the catheptic activity; it is much more probable that the arginase is connected with these autolytic processes.

Further observations are necessary for elucidating the mechanism of growth of malignant swellings and the influence which such swellings exert on the organism. The relations existing between the effects of the intracellualr enzymic systems arginase and cathepsin, and the typical respiration ferments, such as the aerobic dehydrases, of which the xanthine dehydrase[6] may be specially mentioned, deserve careful investigation.

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[8] A. Purr, *Z. f. Krebsf*, 1935, **41**, 483.

The Elephanta Caves.

THE rock-cut sculptures at Elephanta, like others in the different parts of the country, are decaying under the influence of weather and moisture, apart from the mantle of vegetation. The decomposing effects of the latter due to the exudation of organic acids have been undermining these mural decorations for generations, and several attempts have been made to arrest the process of disintegration, and preserve their architectural beauty. The Government of India, recognising the supreme importance of protecting these historical works of art from the ravages of the elements, have appointed a strong Committee to investigate the causes of deterioration and to suggest remedial measures. The Committee is composed of Mr. J. F. Blackiston, Director-General of Archæology, Dr. S. S. Bhatnagar, Professor of Chemistry, the Punjab University, Mr. A. Croad, Superintending Engineer, Central Public Works Department, and Mr. S. N. Gupta, Principal, Mayo School of Arts. The Committee will commence their investigations in November.

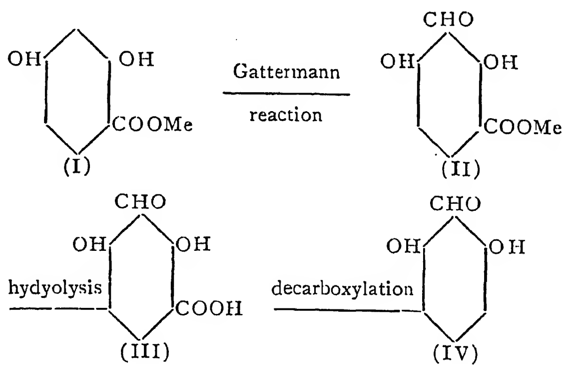
LETTERS TO THE EDITOR.

CONTENTS.

A Synthesis of γ-Resorcylaldehyde.

METHYL β-resorcylate (I) does not undergo the Gattermann reaction under the usual conditions. It is found, however, that under special conditions, *viz.*, in the presence of anhydrous aluminium chloride dissolved in dry ether[1] the reaction proceeds very smoothly and a high yield of the aldehyde-ester (II) is obtained. The aldehyde group is found unexpectedly to enter exclusively the usually inaccessible γ-position in the resorcinol nucleus. This welcome observation has made possible a simple synthesis of γ-resorcylaldehyde, which has been synthesised in the following manner:—

Methyl 2 : 4-dihydroxy-3-aldehydo-benzoate (II), the product of the Gattermann reaction on methyl β-resorcylate (I) was hydrolysed almost quantitatively under properly regulated conditions by cold dilute alkali (48 hrs.) to the free acid (III). The acid (III) on decarboxylation by heating with water in a sealed tube at 100–110° gave γ-resorcylaldehyde (IV), m.p. 155–156° in a fair yield (30%).



γ-resorcylaldehyde has been very recently synthesised by a different method from 2-acetyl resorcinol through a number of stages.[2]

The constitution of the aldehyde ester (II) was conclusively established by Clemmensen-reduction followed by partial methylation, when known methyl 2-hydroxy-3-methyl-4-methoxy benzoate of proved constitution[3] was obtained. A number of derivatives and related compounds have also been prepared.

A detailed account of this investigation will shortly be published elsewhere.

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M. C. LAIWALLA.

Ismail College, Andheri, Bombay,
and
Royal Institute of Science, Bombay,
October, 1936.

[1] Shah, *Curr. Sci.*, 1934, 157.
[2] Limaye, *Rasayanam*, 1936, **1**, 13.
[3] *Cf.* Jones and Robertson, *J.*, 1932, 1689.

Action of Thionyl Chloride on Esters of Salicylic Acid in the Presence of Catalysers.

COPPER or its chlorides work as catalysers for the interaction between sulphur mono- or di-chloride and esters of salicylic acid but fail to behave similarly when thionyl chloride is used. In the latter case they (*i.e.*, copper or its chlorides) are required in molecular proportions. These reactions were studied by Hirve, Jadhav and Chakradeo[1] and products of the type $(C_6H_3OH.COOR)_2S$ were obtained, where R represents CH_3, C_2H_5, etc. The explanation given by these authors was that thionyl chloride was first converted into sulphur monochloride, sulphur dichloride and sulphur dioxide, copper also taking part in the reaction. The former two then reacted with the esters of salicylic acid as mentioned in the beginning.

In search of catalysers for the interaction between thionyl chloride and esters of salicylic acid, almost all the metals or their chlorides were tried. Out of them zinc dust, iron dust and the chlorides of zinc, iron, tin, bismuth and antimony work satisfactorily, 0·1 to 0·2 g. being sufficient.

The most suitable proportion for the reaction was found to be two molecules of thionyl chloride to two molecules of the ester, though it was found that out of the two molecules of thionyl chloride, only one was actually used up, the second one being swept away by the hydrochloric acid gas evolved.

The reaction took place with copious evolution of hydrochloric acid gas and was over within about six hours at room temperature. The resulting products were identical with the thioethers obtained by Hirve, Jadhav and Chakradeo. In no case did any sulphur precipitate.

As only one molecule of thionyl chloride is required in the reaction for every two molecules of the ester and as hydrochloric acid gas is evolved, the reaction seems to have taken the following course:

$$SOCl_2 \longrightarrow S + O + 2\,Cl,$$

the two chlorine atoms going with the two hydrogen atoms from the two benzene rings, the sulphur atom taking the place of these two hydrogen atoms and the oxygen atom being liberated as such, *i.e.*,

$$2\,C_6H_4\cdot OH\cdot COOR + SOCl_2 \longrightarrow (C_6H_3\cdot OH\cdot COOR)_2S + 2\,HCl + O.$$

The oxygen atom was searched for in the form of oxygen gas or in the form of sulphuryl chloride, *i.e.*,

$$SOCl_2 + O \rightarrow SO_2Cl_2,$$

but it could not be detected in any of these forms. Hence it is possible that it is used up in oxidising the organic substances whereby the yields were always found to be not more than 73 per cent.

The above explanation amounts to the same thing as saying that the catalysers act as double catalysers; firstly they convert thionyl chloride into sulphur dichloride and oxygen, and then bring about the condensation between sulphur dichloride and the esters of salicylic acid. The action of sulphur dichloride on the methyl, ethyl and phenyl esters of salicylic acid as well as free salicylic acid was tried in the presence of these very catalysers and the same products were obtained also with evolution of hydrochloric acid. This proves the correctness of the view mentioned in the beginning of this paragraph.

Free salicylic acid does not react with thionyl chloride in the same way as with sulphur dichloride, perhaps because thionyl chloride exerts a dehydrating action on the hydroxy and carboxylic groups which are in ortho position to each other. For this reason the carboxylic group requires to be protected by esterification. As no dehydrating action is exerted by sulphur dichloride, such a protection becomes unnecessary in its case.

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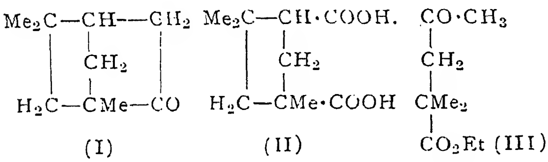
Y. M. CHAKRADEO.
S. V. SHAH.

Rajaram College,
Kolhapur,
September 26, 1936.

[1] *J. Univ. Bomb.*, 1933, 128; *J. Ind. Chem. Soc.*, 1934, 551; and *J. Am. Chem. Soc.*, 1935, 101.

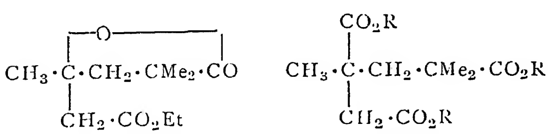
Experiments towards the Synthesis of *Iso*fenchone and Its Degradation Products.

THE classical investigations of Wallach, Aschan and their collaborators[1] have shown the correctness of Semmler's formula for *iso*fenchone (I). Direct evidence by synthesis, however, has been wanting for the constitution of either *iso*fenchone or any of its products of degradation, *e.g.*, *iso*fenchocamphoric acid (II). The present investigation has been undertaken with a view to filling such a gap, and a preliminary report is now made of the results obtained so far.

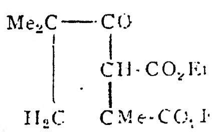


(I) (II) (III)

Ethylmesitonate[2] (III) (ethyl $\alpha\alpha$-dimethyl lævulate), b.p. 108–110°/25 mm. (Semicarbazone, m.p. 154° ; 2 : 4-dinitrophenylhydrazone, m.p. 98°) has been condensed with zinc and ethyl bromoacetate to yield the lactone of ethyl β-hydroxy-$\beta\delta\delta$-trimethyl adipate (IV), b.p. 137–38°/6 mm. The lactonic ester adds KCN at 220° and the intermediate cyanoester yields on hydrolysis with concentrated HCl $\beta\delta$-dimethylpentane-$\beta\delta\epsilon$-tricarboxylic acid (V, R = H), m.p. 172°. The corresponding ester (V, R = Et) prepared by alcohol vapour method with



(IV) (V. R = H, Et)



(VI)

concentrated H_2SO_4, boils at 125–128°/1–2 mm. The constitution of the compound (VI) obtained from the ester (V) by cyclisation is being confirmed. Further work on the synthesis of *iso*fenchone from (VI) is in progress.

My thanks are due to Prof. P. C. Guha for his interest in the work.

S. K. RANGANATHAN.

Department of Organic Chemistry,
Indian Institute of Science, Bangalore,
October 1, 1936.

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[1] Wallach, *Annalen*, 1908, **362**, 191; **363**, 5.
Wallach and Homberger, *Ibid.*, 1909, **369**, 97.
Aschan, *Annalen*, 1912, **387**, 1.
Sandelin, *Ibid.*, 1913, **396**, 285.

[2] Pinner, *Ber.*, 1882, **15**, 529; *cf.* Anschutz and Gillet, *Annalen*, 1888, **247**, 99.

A Volumetric Method for the Estimation of Moisture.

OF the two main methods, oven drying and distillation with an entrainer, available for the determination of moisture in substances such as starch and cotton, the former is not always applicable on account of the possibility of decomposition. Thus, except for precautions in the weighing of the highly hygroscopic bone-dry cotton, the moisture content of cotton may normally be estimated by drying in an oven to constant weight, but the method is unsuitable in the case of cotton which contains certain kinds of extraneous matter or has undergone considerable degradation.

For these and other reasons the Marcusson procedure[1] of distilling the substance with a liquid such as toluene or xylene and reading the volume of the water directly has become increasingly popular. This method, however, has not been free from criticism with regard to the time involved, the choice of the entrainer and the entanglement of condensed water. According to Tate and Warren,[2] who have devised a new apparatus, the comparatively satisfactory types of apparatus due to Friedrichs,[3] and to Bidwell and Sterling[4] both lead to inaccurate results. A new moisture tube has also been recently described by Alexander.[5] The extensive literature on moisture estimation apparatus would appear to point to the practical difficulties of the method, notably the removal of water drops from the inside of the condenser; as a result an "additive apparatus correction constant"[5] seems unavoidable. A variation of the process[6] involving the dehydration of the

distillate with anhydrous copper sulphate and assaying the increase of weight of the latter has given low values in our hands.

In the present method the distillate is led into a known volume of a standard mixture of acetic anhydride and pyridine (1 : 3); when the hydrolysis is complete, the excess acetic anhydride is converted into an equivalent amount of acetic acid and acetanilide. The whole is then made up to a convenient volume and an aliquot part titrated against alkali. If x molecules of acetic anhydride were taken and the substance contained y molecules of water, the acetic acid finally obtained is $(x + y)$ molecules; since x is known, the value of y follows. The accuracy of the method is indicated by the fact that 1 c.c. of normal caustic soda solution corresponds to 0·018 g. of water, the problem resolving itself into the estimation of acetic acid in acetic anhydride.[7]

While a water-immiscible liquid is essential for the Marcusson procedure, a solvent such as dioxane, which is miscible with water and forms an azeotropic mixture containing 20% water and boiling at 86·8°/742 mm., can be conveniently employed for the hydrolytic method. Dioxane, however, needs to be carefully purified since ethylene acetal and other impurities in technical dioxane interfere with the estimation.

N. C. MITRA.
K. VENKATARAMAN.

Department of Chemical Technology,
The University, Bombay,
September, 1936.

[1] Marcusson, *Mitt. aus dem Konigl. Materialprufungsamt*, 1904, **48**.

[2] Tate and Warren, *Analyst*, 1936, **61**, 367.

[3] Friedrichs, *Chem. Ztg.*, 1929, **53**, 287.

[4] Bidwell and Sterling, *J. Assoc. Off. Agric. Chem.*, 1924, **8**, 295.

[5] Alexander, *Ind. Eng. Chem. Anal. Ed.*, 1936, **8**, 314.

[6] Migray, *Ind. Eng. Chem. Anal. Ed.*, 1935, **7**, 348.

[7] Menschutkin and Wasiljew, *J. Russ. Phys. Chem. Soc.*, 1889, **21**, 190; "Report of International Glycerol Commission," *Analyst*, 1911, **26**, 316.

Richmond, *Analyst*, 1917, **42**, 133.

Rosenbaum and Walton, *J. Amer. Chem. Soc.*, 1930, **52**, 3366.

Linkage between the Blackish Purple of Sheath and Glume, and Nucellar Brown in Sorghum.

THE grains of grain sorghum are mostly naked and lack the protection of enclosed glumes. Such protection is afforded in part by the seed coats (pericarp) which may be white or coloured. The colours may be degrees of yellow, red[1] or brown.[2]

Some varieties of sorghum possess a nucellar layer[3] just above the aleurone layer. This layer is pigmented and is of a reddish brown colour. Lying under the mesocarp which is starchy and white, this nucellar colour is masked. Nevertheless, according to the thickness of the mesocarp this underlying " vinaceous drab " (Snowden)[4] imparts a violet tint in the white chalky grained varieties, most noticeable in the variety feterita. This nucellar colour is usually absent in the Indian Durra group of sorghums. It is present in many African sorghums and is most marked in the *caffra* sub-series of sorghum.[4] In *Sorghum caudatum*, Stapf. it finds its best representation and expression.

Regarding the nucellar layer Snowden[4] writes as follows :—" The colour in the grain may be confined to the outer pericarp or it may be absent there but present in the nucellar-layer, or again it may be present in both regions. In the first case the coloured part is removed by husking the grain and the colour of the flour is not affected. In the other two cases, however, the colour present in the nucellar-layer cannot readily be separated from the flour and such grains produce a dirty coloured flour which is less esteemed for some purposes, such as making cakes or bread."

Almost all the varieties with brown nucellus are borne on plants whose leaf sheaths and glumes are blackish purple. The reddish purple leaf-sheaths and glume is largely in evidence in the Durra group of Indian sorghums. It has been noted that in this group there is an absence of nucellar brown.

The reddish purple pigment in the leaf sheath and glume has been shown to be dominant to the blackish purple.[5] A factor Q is present in the former and absent in the latter. In crosses between varieties having nucellar brown and those not having them, the presence of nucellar brown has proved a simple dominant to its absence.[6] Thus a reddish purple leaf-sheath and glume

and nucellar brown are dominant to a blackish purple leaf-sheath and glume and absence of nucellar brown, respectively.

An interesting experience is met with when varieties with a blackish purple leaf-sheath and nucellar brown are crossed with varieties having a reddish purple leaf-sheath and no nucellar brown. The first generation plants have both the dominant characters, reddish purple leaf-sheath and nucellar brown. In the second generation instead of the 9 : 3 : 3 : 1 ratio which the independent shuffling of these characters should give, there occurs the 2 : 1 : 1 : 0 ratio of double dominants, and parental groups, and an absence of the double recessive group. This shows that the gene *q* determining a blackish purple leaf-sheath is linked to the gene producing nucellar brown.

In a previous paper[7] the linkage between the Q*q* (factors for leaf-sheath and glume colour) and B*b* (factors for brown colour in dry anther and grain) has been reported. In the present instance it is the brown nucellus below the pericarp instead of the brown-wash on the pericarp. Both these manifestations of brown colour have this in common that they are linked to the *q* factor responsible for the blackish purple pigment on the leaf-sheath and glume.

A number of crosses between these African races and Indian races are under examination at the Millets Breeding Station, Coimbatore, and a fuller paper embodying the results will be published shortly.

G. N. RANGASWAMI AYYANGAR.

Agricultural Research Institute,
Coimbatore,
October 6, 1936.

[1] *Ind. Jour. Agr. Sci.*, 1933, **3**, 594–603.

[2] *Ind. Jour. Agr. Sci.*, 1934, **4**, 81–89.

[3] *Jour. Agr. Res.*, 1928, **37**, 577–588.

[4] J. D. Snowden, *The Cultivated Races of Sorghum*, 1936.

[5] *Ind. Jour. Agr. Sci.*, 1933, **3**, 589–594.

[6] *Jour. Agr. Res.*, 1924, **27**, 53–64.

[7] *Ind. Jour. Agr. Sci.*, 1934, **4**, 90–95.

Some Observations on the Ovule and Embryo-sac of *Sonneratia apetala* Ham.

A FEW observations on the embryology of *Sonneratia apetala* were made by Karsten[1] as early as 1891, but his work is rather fragmentary and also erroneous in some points. A re-examination of this species has therefore been undertaken in connection with the writer's work on the embryology of the Sonneratiaceæ.[2]

Ovule.—The ovules are numerous, anatropous, two-integumented and possess a fair amount of nucellus. Both the integuments take part in the formation of the micropyle. The nucellus does not show a strand of specially differentiated cells in the chalazal region as seen in *Duabanga sonneratioides* and some members of Lythraceæ,[3] but along with the ovule it is markedly bent in this dart towards the raphe.

Embryo-sac.—The primary female archesporium usually extends to more than one cell and more than one megaspore mother cells have been occasionally observed. Usually only one of them develops further. It cuts off a parietal cell, which by subsequent divisions gives rise to a 5–6 cells' thick parietal tissue above the embryo-sac. The formation of linear tetrad of megaspores is similar to that seen in *Duabanga sonneratioides*, and the chalazal megaspore is the functional one. It develops into the 8-nucleate embryo-sac after three successive free nuclear divisions in the normal manner. The mature embryo-sac (after the fusion of the polar nuclei) is 4-nucleate due to the early degeneration of the antipodals, just as in *Duabanga sonneratioides*[3] and Lythraceæ. It is a long and narrow structure but even then it has never been seen to reach the epidermis at the micropylar end of the nucellus after crushing the parietal tissue as stated by Karsten.

The structure of the synergids and egg conforms to that observed in *Duabanga sonneratioides*. The polar nuclei meet at about the middle of the embryo-sac, move upwards and finally fuse with each other near the egg-apparatus.

J. VENKATESWARLU.

Department of Botany,
Benares Hindu University,
September 24, 1936.

[1] Karsten, G., *Bibl. Bot.*, 1891, 22 (as cited by K. Schnarf in *Vergleichende Embryologie Der Angiospermen*, 1931).

[2] Venkateswarlu, J., *Curr. Sci.*, 1936, **4**, No. 10.

[3] Joshi, A. C., and Venkateswarlu, J., *Proc. Ind. Acad. Sci.*, B, 1936, **3**, 5.

Nucellar Polyembryony in the Rutaceæ.

NUCELLAR polyembryony had been reported in two genera of the Rutaceæ, *Citrus* and *Zanthoxylum*,[1] and recently a third genus *Murraya*,[2] was added to this list. *Citrus* and *Murraya* belong to the tribe Aurantieæ and so it was suggested by Dr. M. A. Sampathkumaran that a further study of some more species of the Aurantieæ might yield interesting results. The present investigation was then undertaken with a view to examine a few local species of the above tribe.

Since *M. Kœnigi* Spreng had been reported to show nucellar polyembryony, another species of the same genus, *M. exotica* Linn., was examined. Out of a total of about 300 ripe seeds examined, the presence of more than

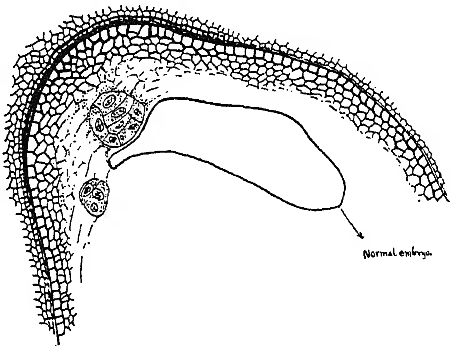

Fig. 1.

Long. Section of ovule of *M. exotica*. Egg-embryo shown in outline.

one embryo was noticed in only four cases. The latter were almost always shrivelled in appearance, the individual embryos themselves being small and ill-developed. Recently another batch of about 300 seeds was examined but polyembryony was found in only one case. A large number of young ovules was sectioned and examined, but only a single case of nucellar embryogeny was observed, obviously due to the rarity of the phenomenon. The two embryos found here were just two groups of abnormally enlarged nucellar cells (Fig. 1).

Aegle Marmelos Correa was the next plant investigated. Though a large number of ripe seeds was examined, not a single case of polyembryony was seen. But on examining serially sectioned preparations of a large number of young seeds, two cases of nucellar embryos were noticed (Figs. 2*b* and 3). In both these cases the nucellar embryo is extremely small when compared with the normal egg-embryo by its side (Fig. 2*a*).

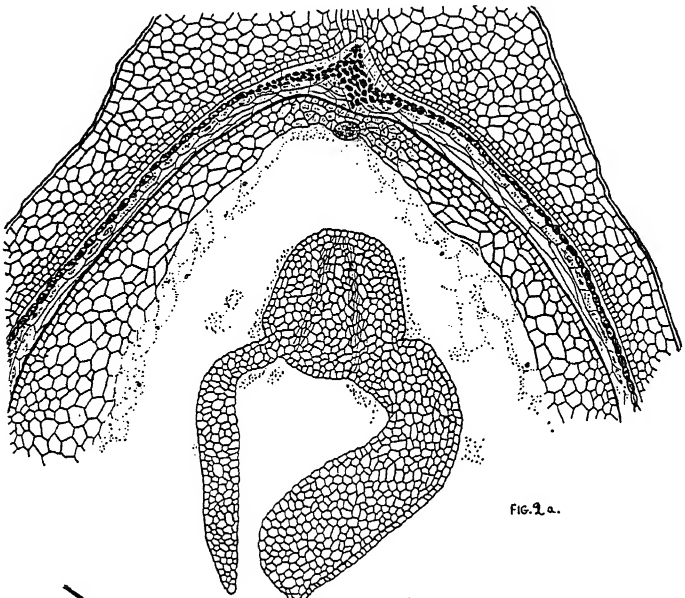

FIG. 2a.

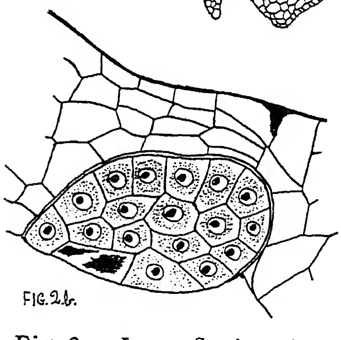

FIG. 2b.

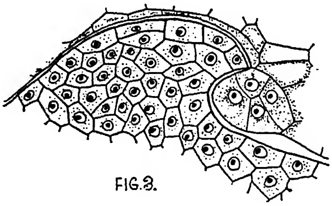

FIG. 3.

Fig. 2*a*. Long. Section of ovule of *Aegle Marmelos*. The nuceller embryo is imbedded in the nucellus near the micropyle.

Fig. 2*b*. Nucellar embryo of Fig. 2*a* enlarged.

Fig. 3. The small nucellar embryo and part of the curved beak-like suspensor region of the normal embryo.

A large number of seeds of *Feronia elephantum* Correa was examined but without finding any case of polyembryony. A few tricotyledonous embryos were found, but their development was not studied. A few ovules were serially sectioned and examined but no clear case of nucellar embryogeny was seen.

Thus two more species of the Rutaceæ, including another genus, are found to show this interesting phenomena. Nucellar embryos are very rarely found in *Aegle* and even then they seem to stop development at a very early stage, whereas in *Citrus* and *Murraya* the nucellar embryos compete strongly during development with the normal embryo. It is probable that we see within the Aurantieæ a sort of progression beginning with the origin of nucellar embryogeny in a form like *Aegle*, leading to forms like *Citrus* and *Murraya Kœnigi*. Within the genus *Murraya* itself we have a similar progression from *M. exotica* to *M. Kœnigi*. A study of further genera of the Aurantieæ may prove to be interesting.

Grateful acknowledgment is made to Dr. M. A. Sampathkumaran for guidance throughout the course of this work.

R. S. CHAKRAVARTHY.

Central College,
Bangalore,
September 5, 1936.

[1] Schnarf, *Embryologie der Angiospermen*, 1929.

[2] Chakravarthy, R. S., *Curr. Sci.*, 1935, **3**, No. 8, 361–362.

Teratological Notes.

ABNORMALITIES have been recorded in the following plants :—

A. *Solanum Melongena* Linn. (*Solanaceæ*).
B. *Phlox Drummondii* (*Polemoniaceæ*).
C. *Jasminum humile* Linn. (*Oleaceæ*).
D. *Bauhinia variegata* Linn. (*Leguminosæ*).

A. The plant of *Solanum Melongena* (Fig. 1) under consideration is very striking because of the following abnormalities :

Fig. 1.

1. Plant is devoid of prickles. This fact is not strange, as in rich soil prickles often disappear.

2. Lower and upper leaves are quite abnormal, more or less lanceolate. Leaves in the middle region are normal, but devoid of prickles.

3. (*a*) Flowers are quite abnormal ; axillary, green. Sepals very much enlarged, pale-green. In the region of the corolla, there is only one leaf of the same size and shape as the sepals, somewhat like a spathe half-enclosing a small bunch of minute leaves on which still smaller leaves are attached. There is no ovary, only a disc-like structure is present above the pedicel.

(*b*) Calyx of 5 sepals, 3 small and 2 big, of the same shape as those in (*a*) but the biggest ones are half the size of those in (*a*). In the region of the petals are two green leaves, lanceolate in shape. Below the sepals is a cup-shaped 3-lobed structure. Ovary is raised on a stalk, resembling a gynophore or

a developing fruit of *Capsicum*; no style, stigmas 2 (Fig. 2).

4. On examining the cross-section of the ovary (Fig. 3) it is found that there are 2 loculi and the placenta is axile, but there are no

Fig. 2.

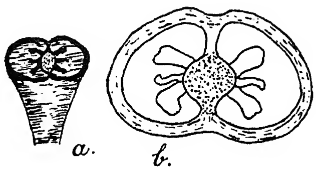

Fig. 3.

ovules, they are only represented by tooth-like structures projecting from the placenta. The remaining portion of the ovary is hollow.

DISCUSSION.—This is a fine case of reversion to the primitive type.

The flowers are stalked, hence no degeneration has taken place in this respect. The lowermost or first whorl of leaves in the flower may be taken as sepals, the second whorl of green leaves in the region of the corolla are petals which have reversed to the leafy form. So have the stamens. The absence of style also shows a reversion to the primitive type in which the stigma was without a stalk.

An example of this type is very interesting from the point of view of illustrating the evolutionary progression of the flower, and also serves as a good example of phyllody (Chloranthy).

B. *Phlox Drummondii.*—Four styles were observed in a few flowers of *Phlox Drummondii* growing in the Botanic Garden, Osmania University. As a rule there are only three styles in *Polemoniaceæ*.

C. *Jasminum humile* Linn.—Three stamens have been observed in some flowers of *J. humile* growing in the Botanic Garden of the Osmania University. The majority of the *Oleaceæ*, as is well known, possess only two stamens of the ancestral tetrandous flower. The specimens under consideration show a partial reversion to the original type.

D. *Bauhinia variegata* Linn.—Only one fertile stamen is found. As a rule there are three to five fertile stamens. Cooke mentions that one fertile stamen is found in *Bauhinia monandra* which is mistaken for *Bauhinia variegata*.

M. SAYEEDUDDIN.
M. A. SALAM.

Botany Department,
Osmania University,
Hyderabad (Deccan),
September, 1936.

Cooke, T., *The Flora of the Bombay Presidency*, Part III.

Hooker, J. D., *F.B.I.*, V, III and IV.

Worseell, *The Principles of Plant Teratology*.

A New Species of Myxosporidian from the Heart of a Marine Fish, *Otolithus ruber*.

A HITHERTO unrecorded species of *Henneguya* has been found as a tissue-parasite in the bulbus arteriosus of *Otolithus ruber*. Kudo[1] records 32 species of *Henneguya* of which all except *H. neapolitana*, are from fresh-water fishes. The only previous record of a Myxosporidian infecting the heart was made by Keysselitz[2] of *Myxobolus cordis*, from the ventricle of *Barbus fluviatilis*.

Of the fish examined in this Laboratory, almost seventy-five per cent. show infection in different degrees. When the infection is fairly heavy, the affected area presents numerous white pustules, which are really the cysts of the parasite containing the spores. Vegetative forms, propagative stages, and spores have been observed. The phenomenon of diffuse infiltration seems to be much pronounced in this parasite, bringing about considerable pathological changes. The development, infection, histopathology, and allied problems connected with this parasite are being studied in detail.

P. N. GANAPATHI.

University Zoological
Research Laboratory,
Madras,
October 5, 1936.

[1] Kudo, R., *Illinois Biological Monographs*, 1919, **5**, 1–265.

[2] Keysselitz, G., *Verh. Ges. deutsch. Natur. u. Arzte, Vers.*, 1908, **79**, 452–453.

The Dorsal Spine of the Lac Insect and Its Function.

IN 1863 von Gernet[1] illustrated (his Fig. 4*b*) a lac insect with two spinoid tubercles which Comstock[2] attributed to an error of observation. However, a somewhat confirmatory observation was made by me[3] in 1923. With these two exceptions Gernet's observation has passed into oblivion.

Since I was able to confirm the rest of Gernet's findings without exception, I came to the conclusion that such a conscientious worker must have actually seen the specimen he illustrated with two spines. I subsequently started to investigate in order, if possible, to vindicate von Gernet. Every morning a handful of lac encrustation was dissolved in alkali solution, and the insects were observed under a microscope for the presence of two spines. An exhaustive examination of material collected from different sources in India proved in vain. The investigation was then extended to include stick lac imported from Tonkin, Indo-China. From stick lac borne by a *Dipterocarpus* tree I got a specimen, *Lakshadia chinensis* whose spinoid tubercle is illustrated in Fig. 1. The slide bearing the object is now deposited in the American National Museum, where my collection of parasites had been previously deposited, and its receipt has been kindly acknowledged by Dr. H. Morrison in his letter, dated 7th July 1936.

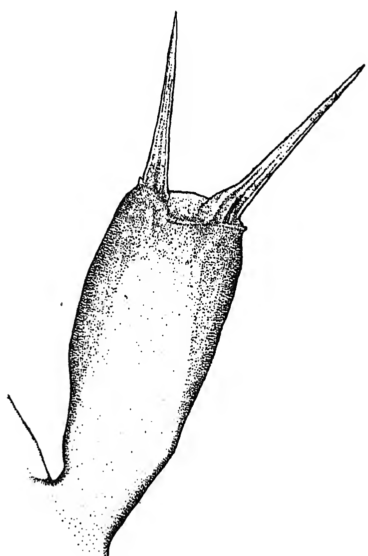

Fig. 1.

A spinoid tubercle bearing two spines; *Lakshadia chinensis* on a *Dipterocarpus* tree from Tonkin; Monsoon crop.

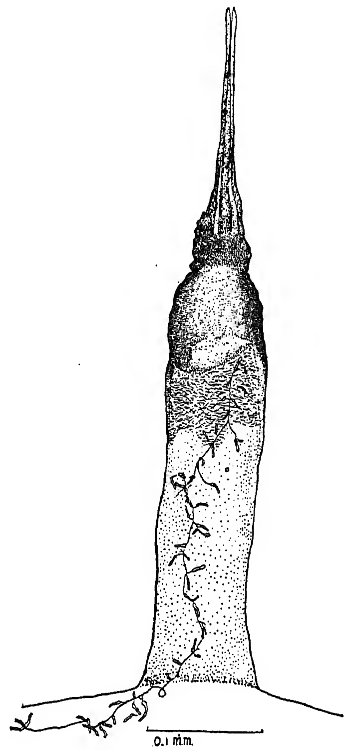

Fig. 2.

A normal spinoid tubercle of *Lakshadia chinensis* on *Cajanus indicus* from Assam; Monsoon crop.

In order to compare the abnormal spinoid tubercle, I have added Fig. 2 which also refers to a *Lakshaida chinensis* insect from Assam, where it was growing on *Cajanus indicus*. The figure shows the thick chitinisation from the terminal spine downwards till the basal portion is like the ordinary skin. A. B. Misra[4] has much simplified his task by showing as though when the chitinisation can be divided into two main parts the spinoid tubercle belongs to a new species (his Fig. 1*d*); and when the chitinisation can be divided into three regions (his Fig. 2*d*) the spinoid tubercle belongs to a still another species. I maintain that these two species of Misra are identical with mine so that his figures and Fig. 2 given here all show the normal but polymorphic spinoid tubercle; while Fig. 1 represents an abnormality so rare that it taxed all my patience to find a single example possessing such a type.

The function of the spinoid tubercle has been considered a puzzle by most authorities. There has appeared only one explanation as to its function[3] and A. B. Misra[5] has refused to be enlightened by it. A typical scale insect grows flat on the twig; on the contrary the lac insect grows vertical to its main axis, a fact also observed by von Gernet. As the secretion of lac grows more copious the cell-wall grows from the ventral side towards the dorsal surface. As the dome-shaped cell of the lac insect enlarges the cell-wall increases in length, the direction being from the ventral towards the dorsal side. If the dorsum of the insect were quite free, the body would finally lie in a pit, while its secretion would be raised like a cylinder around it. But the dorsal skin of the insect is attached to the ceiling of the dome-shaped cell by means of the spinoid tubercle so that, as the cell-wall and the ceiling are gradually raised higher, the skin, attached to the ceiling, is also stretched and the body as a consequence grows vertically. The dorsal spine thus acts like a nail attaching the dorsal skin to the cell dome growing faster; the body of the insect gradually fits into a growing mould as it were, the mould being the secretion of the insect itself.

It naturally follows that should one nail not suffice a second would have to be developed to anchor the skin. An insect with two spinoid tubercles or one tubercle with two spines would thus confirm the above explanation as to the function of the dorsal spine among lac insects.

S. MAHDIHASSAN.

C/o The American Express Co.,
Berlin,
August 31, 1936.

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[1] *Bull. Soc. Imp. Nat. Moscou*, 1863, **36**, Pt. 2.
[2] *Report on Scale Insects*, 1882.
[3] *J. Sci. Assoc. Maharaja's Coll., Vizianagaram*, 1923, **1**.
[4] *Bull. Ent. Res.*, 1930, **31**, Pt. 2.
[5] *Proc. Zool. Soc. London*, 1931, p. 315.

Tadpoles of *Rana tigrina* Feeding on Mosquito Larvae.

DURING rains mosquitoes lay their eggs in waters accumulating in holes, cavities and shallow depressions. But the larvæ, however, are found abundantly in accumulated waters within the inhabited localities and strange though it may seem, they are almost absent from the accumulated water-stretches beyond the limits of human habitations with surroundings of bushes and plants. Repeated observations have elucidated the fact that tadpoles of *Rana tigrina*, with which these shallow pools or water-stretches are infested, voraciously swallow these larvæ. The tadpoles of *R. tigrina* also relish the tadpoles of *Bufo melanostictus* Schneid. Not a single tadpole of the latter species is found in localities where those of the former are abundant. Unlike the common tadpoles of *B. melanostictus*, those of *R. tigrina* lie quietly at the bottom like mud-fish, and whenever any mosquito larva moves meanderingly to get to the surface of water they swoop at it from a distance and swallow it at once.

For verification, tadpoles of *R. tigrina* were reared in experimental tanks and it was observed that they voraciously feed on mosquito larvæ and tadpoles of *B. melanostictus*.

G. C. BHATTACHARYA.

Bose Research Institute,
Calcutta,
May 22, 1936.

The Supposed Sanskrit Seal from Rohtak: A Correction.

I AM indebted to Dr. A. S. Altekar of Benares, who examined my "Bhadramitra" sealing from Rohtak on September 6, for certain important comments on Mr. Jayaswal's reading[1] which I had reproduced in a recent note.[2] As Dr. Altekar rightly said, the first letter in the second line is a simple स *sa*, not a स्य *sya*. The seal, therefore, is not in pure Sanskrit as Mr. Jayaswal thought. A similar combination of the Sanskrit form त्र *tra* with the Prākrit स *sa* (instead of the Sanskrit generative स्य *sya*), has been met with in several coins of the Śuṅga period: *Agnimitrasa, Bhānumitrasa, Bhūmimitrasa*, etc.[3] Dr. Altekar also says, with much justification, that the last two letters, read by Mr. Jayaswal as घट्टे, are by no means clear in the original. These and other criticisms were also made soon afterwards by Rai Bahadur Pandit Prayag Dayal of Lucknow, Rai Bahadur Daya Ram Sahni, now Director of Archæology in Jaipur, and Mr. K. N. Dikshit of the Archæological

(*Continued on page 215.*)

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Vitamin B_1 (Oryzanin, Torulin, Aneurin).

Its Chemistry and Mode of Action.[a]

By RUDOLPH A. PETERS, *Oxford*.

NO review on this subject would be complete without a passing allusion to the work of the pioneers. Without Eijkmann and Grijns[1] and the workers in the Phillipine Islands, such as Braddon, Fraser and Stanton, Chamberlain and Vedder,[1,b] scientific work upon beri-beri could not have started. In India too, the researches of Sir Robert McCarrison are too well known to need further comment.

'Vitamin B' was differentiated as one of three necessary vitamins by McCollum and Davis,[1] the other two being fat soluble A and vitamin C. Only the latter had retained its single blessedness. Vitamin B has become more subdivided as the result of research even than the original fat soluble vitamin A.

Vitamin B_1 is the original antineuritic vitamin which is curative to beri-beri and has been termed torulin, and oryzanin and aneurin.[2] The term antineuritic should be discarded now, as it lays too much emphasis upon the relation to the nervous system, and too little upon the general need among cells for this factor. It disregards the fact that the deficiency of the A vitamin also has effects in the central nervous system.[3] The pure chemistry of vitamin B_1 has advanced much of late. The work of the pioneers among whom we may mention Hopkins, Funk, Hofmeister, Williams and Seidell[4] has finally led to the preparation of the vitamin in a pure state. Crystals of high activity were first obtained in Java in 1926 by Jansen and Donath. More recently the pure vitamin has been prepared in several laboratories at about the same time, namely, Van Veen[5] in Java, Ohdaké[5] in Suzuki's laboratory in Japan, Windaus[6] and colleagues in Germany, Kinnersley, O'Brien and Peters[5] at Oxford in England, and Williams and colleagues in America.[5] The steps which have proved important in the isolation, may be briefly mentioned; the finding that the vitamin was precipitated by basic precipitants, such as silver nitrate and baryta, and phosphotungstic acid; that it was adsorbed from very impure and dilute solutions with fuller's earth, from which it could be eluted by baryta, or quinine; that it was adsorbed by charcoal from which it could be removed by acid alcohol; that the precipitation with phosphotungstic acid could be made selective by varying the pH of the solution: and that crystallisation is interfered with by traces of salts. To this must be added the considerable information which gradually accumulated upon the conditions of stability of this factor. It is for instance destroyed at 120° C. by the autoclave and more readily by heat in alkaline solution but not at lower temperatures to the same extent. It is not destroyed by nitrous acid,[11] though this has been disputed. It is eluted from most natural sources by slightly acid 50% alcohol. The sulphates and nitrates of vitamin B_1 are known, but the form isolated is usually the hydrochloride as colourless plates or needles, soluble in lower strengths of alcohol, but rather insoluble in absolute alcohol. It is believed to be the vitamin for several reasons; we may mention the constancy of composition and identity of biological and of spectroscopic behaviour of different preparations made from rice and yeast in

[a] There is no attempt to make this review comprehensive in detail, but to indicate the present position of research.

[b] The book of Vedder on beri-beri must always be a classic.

different laboratories by rather different methods. It is now known to contain S[6] and has the composition $(C_{12}H_{17}ON_4S.HCl)Cl$. The precipitation properties recall those of histidine. Usual methods of degradation with the small amounts of substance available, amounting perhaps to not much more than 10 gm. in the hands of any one individual, proved of little avail,[c] until Williams[7] and his colleagues[d] brilliantly chose the unusual reagent sulphite; under the action of this the vitamin splits smoothly to a pyrimidine and a sulphur containing substance 4-methyl 5′β-hydroxyethyl thiazole which can be oxidised to 4-methyl thiazole 5 carboxylic acid.[8] This has been established now by synthesis in an excellent work by Clarke and Gurin.[9] Let us now see how some of the facts about the vitamin fit with this knowledge. Some general properties are summarised in Table I.

TABLE I.[10]

Properties of vitamin B_1.

	References	pH 1–4	4–7	7–9	9–11
Colour ..	(1) (2)	Colourless	Colourless	Yellow fading to colourless (R)	
Spectrum ..	(3) (4) (5) (9) (10)	247 $m\mu$	234 $m\mu$ and 268 $m\mu$	Increase in absorption at 233 $m\mu$ and appearance of broad band at 330-340 $m\mu$ rapidly fading	
Titration ..	(6) (7) (11)	..	Basic group pK 4·8	Pseudo-acid group at pH 9·0 appears slowly with pK 6·5 [R] and requires 2 equivalents of alkali	
Capacity for giving azo colour reaction	(8)	Stable	Stable	Tending to become unstable and much lost in performing alkaline titration (I)	
—SH. reaction ..	(1)	..	..	No	Present only after warming with strong alkali
Activity ..	(2)	Normal	Normal	Normal	Lost gradually on heating (I).

R = Reversible. I = Irreversible.

(1) Van Veen, 1933; (2) Kinnersley *et al.*, 1935; (3) Peters and Philpot, 1933; (4) Smakula, 1935; (5) Holiday 1935; (6) Birch and Harris, 1935; (7) Moggridge and Ogston, 1935; (8) Kinnersley and Peters, 1934; (9) Winterstein *et al.*, 1935; (10) Heyroth; (11) Ogston and Peters.

Let us first consider the behaviour upon titration. The vitamin titrates to give a normal weak basic group at pH 4·8, but upon making more alkaline than pH 7·0, there is a tendency for the pH to swing back to the acid side after each addition of alkali; until two equivalents are reached, the vitamin cannot be titrated permanently over to the extreme alkaline side. This is believed to be due to a quaternary N atom of unusually weak basicity. Synthetic methyl thiazoles behave in a similar way provided that they are substituted in the 4 position, and that they are treated with methyl iodide to convert to the quaternary form. These facts are summarised in Table II. It is seen that several properties

TABLE II.

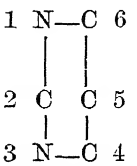
Behaviour of synthetic methyl thiazoles.

	N	Spectrum Band[12]	pK basic[13]
4-Methyl thiazole hydrochloride	Tertiary	251 $\mu\mu$	3·6
2·4-di-Methyl thiazole HCl	Tertiary	254 $\mu\mu$	—
4-Methyl thiazole ethiodide	Quaternary	225 $\mu\mu$	9·5 behaving as B_1

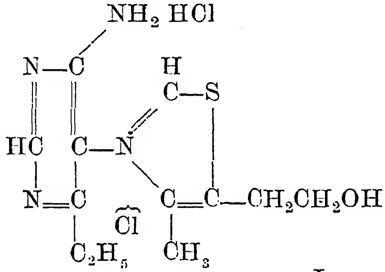
[c] In Oxford we worked up $4\frac{1}{2}$ tons of yeast to obtain about 3·0 gm. Our present best yield from enriched yeast is 100 mg. per cwt.

[d] It is interesting to note that the use of this unusual chemical reagent was due really to the previous biological work; much vitamin had once been lost in an attempt to preserve with sulphite.

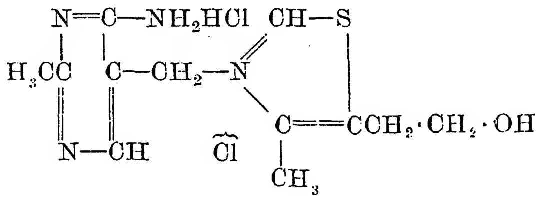
of the vitamin as regards the spectrum and titration curves agree with this value. It is not clear however why the vitamin in neutral solution gives the band at 268$\mu\mu$ as well as that for the quaternary thiazole. The two equivalents of alkali required are somewhat of a puzzle; some think that the thiazole group opens with action of alkali. Against this is the finding that there is no nitroprusside reaction (for —SH) until after warming. The vitamin very easily gives



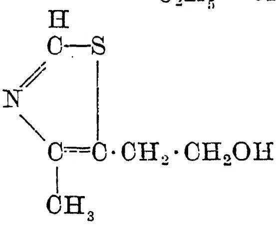
Pyrimidine



I



II



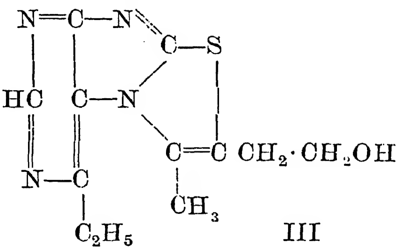
4-methyl 5′β-hydroxyethyl thiazole

off H_2S on warming with alkali without degradation of N to NH_3. The composition of the other fragment is believed to have the pyrimidine nucleus but it is not so clear. It is rather interesting to realise that there has been the feeling from the start of vitamin chemistry, that the compound might be allied to the nucleotides. Williams and colleagues[13] from their own experience originally thought that they were dealing with the 5-amino 4-ethyl pyrimidine; they thought themselves in consonance with Windaus *et al.* Upon the basis of this they originally proposed formula I.

This formula has now been synthesised by Bergel and Todd,[14] who find that it has no vitamin activity. At the same time Williams *et al.*[13a] state that they have abandoned the original view and that they incline to formula II, which was actually first proposed by two Japanese on theoretical grounds.[15]

Part of their evidence is that they have obtained from the vitamin with liquid ammonia a free base $C_6H_{10}N_4$ which agrees in spectra best with 5-alkyl 6-amino pyrimidine. It seems that we shall have to await synthesis before we feel confidence in the present proposal. It must be edtadmit that the reaction producing thiazole is a curious one, and that from an analogy with uric acid, the degradation products may prove to follow rather unusual lines. Not much modification of the structure is required to approximate to adenyl thio methyl pentose isolated long ago by Suzuki[16] and colleagues.

A compound that is playing some part in the assessment of structure is thiochrome,[17,e] which is a quinochrome or blue fluorescent compound. The oxidation of mere traces of vitman B_1, even at biological C_H under certain conditions, produces a brilliantly fluorescent compound (ultra-violet light), which is in appearance much like lumichrome a degradation product of the flavin component of vitamin B_2. The latest suggestions attribute to this the formula III.



III

The synthetic I does not give the same fluorescent product upon oxidation as the vitamin. There are some features of thiochrome unexplained by formula III. It still gives the quaternary shift in the titration[18]

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[e] Found and identified in yeast extracts,

though there is a change in the state of the S.[f]

The azo reaction, behaviour to diazotised sulphanilic acid, deserves especial mention.[19] At the ordinary alkalinity of the Pauly reaction there is hardly any colouration; but in a rather more alkaline medium, there is a marked formation of a pink colour, which comes to maximum in 30 mins. and then fades. In presence of formaldehyde the colour is more stable, and standards can be made up for vitamin estimation, which last for several weeks. At first it was thought that the reaction must be due to the NH_2 group at position 6, but it seems to be given by the thiazole part of the molecule.[20] The reaction is useful for fairly pure vitamin but not available at present for dilute impure solutions. It is not yet certain to what part of the molecule the special properties of the vitamin as catalyst are due (*cf.* 11).

Now that the constitution of the vitamin seems to be advancing towards a settlement, we are in a position to ask the next question, what is the exact function of the vitamin in the body? Does it merely act as some integral part of a surface membrane, or is it an essential catalyst? If the latter, what reaction does it catalyse?

THEORY OF ACTION.

There have been in the past two main views as to the function of the vitamin, (1) that it was concerned with carbohydrate metabolism[21] and (2) that it was related to tissue oxidations.[22] These views were early propounded, and have given rise to much work, some of it unfortunately not sufficiently controlled to permit of the conclusions drawn.[50] For instance many things will disturb carbohydrate metabolism indirectly, a high blood sugar or lactic acid content may merely mean that an animal has been given exercise or is suffering from anoxæmia. Related to this question has also been the vexed difficulty of inanition. Fortunately recent work in the Biochemical Laboratory at Oxford[g] has gone some way to clarify the position, and has indicated that there was truth in each of these earlier views. At first we supported the lactate oxidase theory but have abandoned this. Our latest theory, which has much experimental support, is that vitamin B_1 is concerned in the oxidation of pyruvic acid (an essential stage in the intermediary metabolism of the carbohydrates). Let us consider the proof of this. The following experiment shows the main points in question. A pigeon is fed to the stage of convulsions with polished rice. Parts of the brain,[23] the cerebral hemispheres and the optic lobes, were taken out of the animal and minced under careful conditions; they were then placed into the bottles of a suitable micro respirometer (Barcroft or Warburg type) in Ringer bicarbonate or Ringer phosphate solutions. The latter is better for this purpose. The amount of solution usually used is 3·0 c.c. and it may contain either lactic acid or pyruvic acid as substrates. At pH 7·3 (the pH of the blood approx.), the respiration of avitaminous brain rapidly falls off as the tissue is allowed to respire at 38° C. If however as little as 2γ of vitamin is added, the respiration of the samples is much altered. That with vitamin will increase largely as compared with the control. There is here therefore

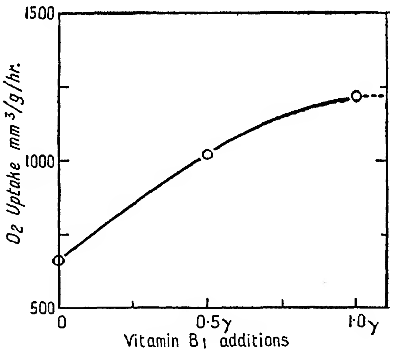

Fig. 1.

an *in vitro* action of vitamin B_1. The effect can be observed with amounts of $0·2\gamma$ or even less; and as the amount of oxygen taken up is much greater than the amount of vitamin added, it is clear that we are dealing

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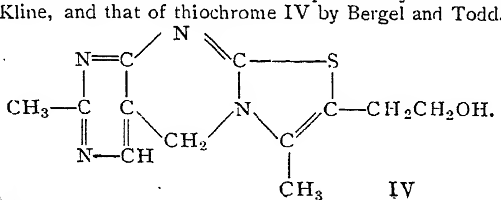
[f] Since writing the above, the synthesis of vitamin B_1 as formula II has been accomplished by Williams and Kline, and that of thiochrome IV by Bergel and Todd.



IV

[g] The writer's colleagues in this work have been H. W. Kinnersley, R. B. Fisher, N. Gavrilescu, A. P. Meiklejohn, R. Passmore, H. W. Sinclair, R. S. Thompson, R. E. Johnson, H. Rydin, J. R. O'Brien, G. K. McGowan.

with a catalytic action. The effect is hardly noticeable with the normal brain, and it disappears progressively with the degree of cure of the animal, even when no food has been given. This settles definitely that there is a deficiency of vitamin B_1 in some part of the brain which is a specific and not a general deficiency (it is not due to general inanition[h]). The deficiency shows itself as a change in the oxidative capacity of the tissue (respiration if we prefer the term), and further it may be added that (with the exception of glucose it is not shown with other substrates used among which we may mention especially succinate. It is a defect of a peculiar type in the intermediary metabolism of the carbohydrates. Of course it cannot be said that the brain in the bottles is behaving like normal brain *in situ*, but there is enough evidence to show that it is not an entirely artificial story. Among the peculiar facts discovered about these respiring enzyme systems was one which excited considerable interest, namely, the finding that pyruvate was present in the bottles after avitaminous brain had respired *in vitro* in lactate solutions. The presence of vitamin reduced almost to normal these abnormal amounts of pyruvate. They are not found with normal brain unless there is also a poison in solution (such as iodoacetate or arsenite). It might be argued in this latter case that they appear owing to the abnormal effect of the poison, but their presence in the avitaminous system seems very strong evidence that pyruvate is really a stage in the normal oxidation of lactate. The story does not however stop here, because it has been noticed that in the blood of the polyneuritic pigeon and rat there is an abnormal accumulation of pyruvate as well as of lactate, which had been previously known. The same state of the brain can also be noticed in the rat, though it is much less marked, and the blood is also found to have a raised pyruvic acid. Quite recently there has come to hand from China (Platt and Lu)[24] the interesting information that in beri-beri too this happens. It is indeed possible that the presence of abnormal pyruvic acid in the blood may be found to be a clinical test of some importance for the beri-beri condition. There has not been found abnormal pyruvic acid in any other clinical condition at the present time.[25] Here, we have a beautiful example of the importance of carrying out investigation for its own sake. From experiments carried out upon dead tissue with the academic object of advancing the study of an enzyme system has come something which may prove to be of real clinical value. It is of the greatest theoretical interest that there should be such definite evidence for the presence of pyruvic acid as a normal intermediary metabolite. Prominence has been given to this by the Embden Meyerhof[26] scheme of carbohydrate degradation, the evidence for which has so far been culled from tissue brei poisoned with iodoacetic acid. The conclusions reached have been recently embodied in the accompanying provisional scheme (Fig. 2).

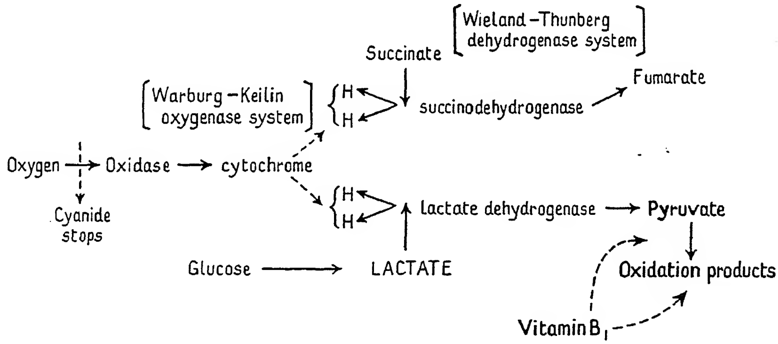


Fig. 2.

Hydrogen is mobilised by the specific dehydrogenase systems and transferred to the activated oxygen to form H_2O_2. Scheme adopted from Keilin with additions from Green and Ogston.

Further facts have been ascertained about the behaviour of these enzyme systems which are still rather obscure. Among these we may mention the curious action of pyrophosphate in helping the maintenance of respiration when the substrate is lactate. The fate of the pyruvic acid is still a mystery. In unpublished experiments with G. K. McGowan

[h] The inanition is secondary.

it seems certain that it is not all burnt, but no support has been obtained for the common conception that it is oxidised *via* succinic acid. Unlike the suggestions which arise from muscle (Embden Meyerhof) the pyruvic acid in these brain systems has not been found by Johnson to interact with α glycerophosphate. The poisons iodoacetic acid and fluoride both inhibit the vitamin effect, but only in the presence of the former does pyruvate accumulate from lactate. Arsenite also stops the vitamin action in small traces and leads again to pyruvate accumulation.[27]

It is believed that this biochemical lesion is noticeable first in the lower parts of the brain and that as the vitamin B_1 deficiency increases it spreads to other parts also. In harmony with this view Rydin[23] found that in the bird which did not show the true symptoms so well known to be characteristic of polyneuritis, there tended to be a deficiency in the cerebrum without one elsewhere.

It is clear that whatever may be the state of the nerves in human beri-beri, in the case of the animal the well-known acute symptoms of vitamin B_1 deficiency are associated directly with the loss of vitamin B_1 from the central nervous system. Later as the result of this loss, further changes may set in elsewhere which cannot then be readily cleared up, as is the common experience in dosing one of the chronic cases with vitamin B_1.

These recent results embodied in the pyruvic acid oxidase theory appear to decide an essential function of this vitamin, *viz.*, that it catalyses a tissue reaction ; it is not yet certain that it is the only one. Grosser changes occur in animals and man as the result of deficiency, accumulations of lactate and œdema, and in the terminal stages alterations in carbohydrate tolerance and brady cardia.[28] The lactate accumulations may be explained on the pyruvic acid theory, but it is possible that they are also indirect in another sense due to some such action as excessive adrenalin. Behaviour to insulin is normal.[29] The writer believes that the biochemical lesion in the lower part of the brain induces these secondary disturbances in carbohydrate regulation in the body (*via* hypothalamus and associated centres). This regulation has been shown in recent years to depend upon the control of this part of the brain.[30] Such brain disturbance might again account for failures in temperature regulation as well as the reported excessive storage of glycogen (Abderhalden and Wertheimer)[31] in the liver. In other words, the direct biochemical lesion induces secondary chemico-physiological changes in the inter-tissue transfer of carbohydrates. Oedema appearance is not yet explained, though the kidney in birds also suffers from faults due to lack of vitamin B_1 ; nor again can we yet properly explain the failure in appetite, that early and most constant symptom of deficiency of this vitamin, which has been much investigated by Cowgill and colleagues[32] especially in dogs. It is this which leads to the accompanying inanition. The failure of appetite (anorexia) is a feature of great importance in practical nutrition and should be treated with concentrated vitamin B_1 preparations.

Methyl Glyoxal.

Geiger and Rosenberg[33] have described the presence of methyl glyoxal ($CH_3.CO.CHO$) in urine of infants suffering from vitamin B_1 deficiency. This is of theoretical as well as practical interest. The methyl glyoxal theory of carbohydrate degradation has been given up lately, though there are observations by Gaddie and Stewart[34] which suggest that it may still be needed. This abnormal methyl glyoxal may prove to be due to the lack of glutathione. Glutathione is well known to be a co-enzyme to glyoxalase which has for long been considered to be deficient in beri-beri animals (Findlay).[1] There have been several papers describing change in the —SH compounds in this condition,[35] but this matter is not definite. The claims of Randoin and Fabre have been vigorously disputed by Mattei. Methyl glyoxal is entirely absent from the brains of avitaminous pigeons.[35a]

Adenine.

The relation of adenine to part of the proposed structure of vitamin B_1 is suggestive. Vitamin B_4 (Reader[36]) consists largely of adenine, and Guha[37] has suggested that irradiated adenine has action in relation to these compounds. His first idea that it would function as vitamin B_1, he has now abandoned. It is the writer's belief that some unknown relation exists. Dr. Holiday supplied him with a specimen of irradiated adenine upon one occasion which had a weakly curative effect upon pigeons. Lately Birch and Mapson[38] have stated that the heart of the vitamin B deficient rat is more

susceptible to the action of adenylic acid, and that there is less de-aminase.

TESTS FOR VITAMIN B_1 AND STANDARDISATION.

Vitamin B_1 is at present standardised against a particular sample of acid clay supplied by Jansen from Java, 10 mg. of this equals 1 International Unit. It seems agreed that 1 I.U. is approximately 2γ vitamin B_1 Cl. HCl, though some quote the figure a little higher, up to $3 \cdot 3\gamma$.[39]

The tests available are as follows: (1) a colour reaction formaldehyde-azo test for pure forms of vitamin, (2) the so-called catatorulin test,[39] making use of the brain enzymes from the avitaminous pigeon; (3) the brady cardia test, in which the slowing of heart in rats is used as a test; (4) growth tests in rats; (5) maintenance tests in pigeons; (6) protective tests in the tropical rice-bird *Munia Maja*; (7) curative tests to the pigeon in ophisthotonus.[i]

AMOUNTS OF VITAMIN B_1 REQUIRED.

According to recent estimates, man requires 250–500 units of vitamin B_1 daily, *i.e.*, about 1·0 mg. vitamin B_1 for health. The amount varies with the rate of metabolism and therefore with the weight. For clinical trials Vorhaus, Williams and Waterman[40] consider it essential to give doses up to 10 mg. of crystalline vitamin B_1. These authors have evidence that it is of value in various neuritic conditions and they are supported by others such as Ritchie Russell[41] and Strauss[42] in alcoholic polyneuritus. From clinical impressions of beri-beri, we should look for its use preferably by injection, in loss of appetite, œdema, palpitations and breathlessness, and painful muscles.[43]

There is a rather wide difference between the amount of vitamin B_1 required to produce a temporary cure in a pigeon (about 10γ for 5 days) and that needed for the maintenance of health at maximum possible weight, at least 20γ per diem.[44] There is evidently much more work to be done to clarify the position. The rat (weight 400 gm.) needs about 5γ per diem.

[i] For Schopfer's test, see below.

VITAMIN B_1 VALUES OF FOODSTUFFS.

A recent determination of vitamin B_1 values has not substantially altered previous conceptions. The subject has been well reviewed by Aykroyd.[45] It is important to remember that the vitamin B_1 content of foods such as milk or yeast may be variable. The richest sources are vitamin enriched yeast and wheat germ. Then come liver, pork, beans and egg yolk. Recent estimations have been made by Baker and Wright.[49]

VITAMIN B_1 IN URINE AND BLOOD.

Urine.—It has been known for some time that vitamin B_1 was present in urine and could be adsorbed upon charcoal. Recently, studies with the evaporated dry solids of urine, with an acid clay adsorption product from urine and with the urine itself agree in the conclusion that avitaminous urine from rats contains very little B_1; on the other hand that from animals upon a normal diet contains this vitamin.[46] Further it seems that giving a dose of vitamin B_1 to a human will increase excretion but not to the full extent of the dose, supposing the person to be saturated. There is evidently more to be explained. The average excretion of healthy adults was of the order of 12–35 I.U. whereas the daily diet must contain about 300 units for health.

Blood.—Studies upon blood have been delayed by the want of a sufficiently sensitive test. The micro-organism test of Reader with Streptothrix corallinous was valuable but not quite specific. Recently Schopfer[47] has found that a mould (Phycomyces Blakesleeanus) can be grown upon media so that minute amounts of vitamin B_1 will act as an essential growth factor. Within limits of $0 \cdot 1$–$1 \cdot 0\gamma$ per 10 c.c. of medium, the weight of mycelium is proportional to the amount of vitamin B_1 added. Under special conditions worked out by A. P. Meiklejohn,[48] the B_1 content of blood can be estimated; the values reached are for pigeons normal 27γ per 100 c.c. blood avitaminous, $5 \cdot 5\gamma$ per 100 c.c., and for some normal humans 8–10γ per 100 c.c.; *i.e.*, in the human where B_1 deficiency shows less readily, there is an average lower concentration of vitamin B_1 than in the pigeon. Tests upon patients are hoped to give

concrete evidence as to the degree of avitaminosis.

In reviewing the many-sided problems still presented by this important growth factor, it is felt that the future years cannot fail to reveal other interesting aspects of its action. Though not the first vitamin to be isolated or prepared synthetically, it may fairly be claimed that it is the first case in which vitamin deficiency symptoms have been correlated with a biochemical reaction, as well as being the first instance of a thiazole ring in nature.

REFERENCES.

[1] For references see *Vitamins; A Survey of Present Knowledge*, 1932, Ref. No. 167.

[2] Jansen, *Nature*, 1935, **185**, 271.

[3] Mellanby, E., *Brain*, 1935, **58**, 141.

[4] For references see *Chemistry Centenary Meeting*, 1931, *Brit. Assoc. Rev.*, p. 131.

[5] For references see Kinnersley, O'Brien and Peters, *Biochem. J.*, 1935, **29**, 701.

[6] Windaus, *et al.*, see (5).

[7] Williams, *J. Am. Chem. Soc.*, 1935, **57**, 229; Williams, Buchman and Ruehle, *J. Am. Chem. Soc.*, 1935, **57**, 1093; Buchman, Williams and Keresztesy, *Ibid.*, 1849.

[8] Windaus, *et al.*, *Z. Physiol. Chem.*, **228**, 27; Tomlinson, *J. Chem. Soc.*, 1935, 1030.

[9] Clarke and Gurin, *J. Am. Chem. Soc.*, 1935, **57**, 1876.

[10] Table I, (1), (2), (3), (4), (5), (6), (7), (8), (9), see [11], (10) Heyroth, *Biochem. J.*, 1936, **30**, (11); Ogston and Peters, *Biochem. J.*, 1936, 30.

[11] Kinnersley, O'Brien and Peters, *Biochem. J.*, 1935, **29**, 2384.

[12] Ruehle, *J. Am. Chem. Soc.*, 1935, **57**, 1887.

[13] Williams and Ruehle, *Ibid.*, 1857.

[13a] Williams, *J. Am. Chem. Soc.*, 1936, **58**, 1063.

[14] Bergel and Todd, *Nature*, 1936, **138**, 76.

[15] Makino and Imai, *Z. Physiol. Chem.*, 1936, **239**, 1.

[16] Suzuki, Odake and Mori, *Biochem. Zeit.*, 1924, **154**, 278.

[17] Kuhn, Peters *et al.*, Barger *et al.*, see (11) and (14) and 10, 11.

[18] See (10), (11).

[19] Kinnersley and Peters, 1934, see (11).

[20] Private communication from Dr. A. R. Todd.

[21] For references see (1), (23).

[22] See also Rydin, Inaug, *Dissert*, 1935, Uppsala.

[23] Peters, *Lancet*, 1936, p. 1161.

[24] Platt and Lu, *Proc. Physiol. Soc.*, *3rd Gen. Congress Chinese Med. Assoc.*, 1935.

[25] Johnson, Meiklejohn, Passmore and Thompson, *Biochem. J.*, 1935, **29**, 2506.

[26] See Meyerhof and Kiessling, *Biochem. Z.*, 1933, **264**, 40 and other papers.

[27] Unpublished observation. (McGowan and Peters.)

[28] Drury, Harris and Maudsley. Not to be confused with pigeon heart block factor, *J. Biol. Chem.*, 1930, **73**, 335, 17.

[29] Unpublished observations of Kinnersley and Peters.

[30] Donhoffer and McCleod, *Proc. Roy. Soc.*, London, 1932, **110 B**, 125.

[31] Abderhalden and Wertheimer, *Pflugers Archiv.*, 1933, **233**, 395.

[32] Cowgill, *The Vitamin B Requirement of Man*, 1934, Yale Univ. Press.

[33] Geiger, Rosenberg, *Klin. Woch.*, 1933, **12**, 1258.

[34] Gaddie and Stewart, *Biochem. J.*, 1935, **29**, 2101.

[35] Randoin and Fabre, *C. Rend.*, 1927, **185**, 151; Mattei, quoted from *Chem. Abst.*, 1928, **23**, 1668.

[35a] Gavrilescu and Peters, *Biochem. J.*, 1931, **25**, 1406; Johnson, *Biochem. J.*, 1936, **30**, 32.

[36] Barnes, O'Brien and Reader, *Biochem. J.*, 1932, **26**, 2035.

[37] Guha, *Nature*, 1933, **132**, 447.

[38] Birch and Mapson, *Nature*, 1936, **138**, 27.

[39] Kinnersley and Peters, *Biochem. J.*, 1936, **30**, 985.

[40] Vorhaus, Williams and Waterman, *J. Am. Med. Assoc.*, 1935, **105**, 1580.

[41] Ritchie Russell, *Edin. Med. J.*, 1936, **43**, 315.

[42] Strauss, *Am. J. Med. Sciences*, 1935, **189**, 378.

[43] See Peters, *Proc. Roy. Soc. Med.*, 1934, **27**, 14.

[44] Ammerman and Waterman, *J. Nutrition*, 1935, **10**, 161; and unpublished observations of Carter and O'Brien.

[45] Aykroyd, W. R., *Vitamins*, 2nd Edn., Heineman, 1936.

[46] Harris and Leong, *Lancet*, 1936, 886; Roscoe, *Biochem. J.*, 1936, **30**, 1053.

[47] Schopfer, *Archiv. für. Mikrobiologie*, 1935, **6**, 510.

[48] Meiklejohn, Unpublished results.

[49] Baker and Wright, *Biochem. J.*, 1935, **29**, 1802.

[50] See especially Westenbrink, *Arch. néerl. Physiol.*, 1932, **17**, 239.

Survey of India, to all of whom I am likewise indebted. As the original sealing will now no doubt be subjected to a critical examination by expert epigraphists, who may raise further points about the reading and interpretation of the sealing, I should content myslef on this occasion with publishing only the main criticisms, about which I also feel convinced. I confess that when, after receiving Mr. Jayaswal's reading, I tried to confirm it with the help of Bühler's palæographic chart and Ojha's monograph, I failed to get satisfaction over the supposed स्य *sya*; but as a novice in this line I could scarcely question the authority of so able a scholar as Mr. Jayaswal, to whom I owe my own introduction to the Brāhmi script.

B. SAHNI.

Lucknow,
October 2, 1936.

[1] Jayaswal, *Journ. B. and O. Research Society*, June 1936, **22**, Part 2, p. 62, pl. IV, fig. 18.

[2] Sahni, *Curr. Sci.*, August 1936, p. 80.

[3] *Cat. of Coins in the Ind. Museum*, **1**, 186–189.

Thickness of Bran Layers in Rice.

IN a note about the nutritive value of parboiled rice[1] Sreenivasan and Das Gupta have drawn attention to the fact that coloured varieties of rice (and coarse varieties in general) have thicker bran layers and contain very much more of nitrogen and phosphorus than the superior white varieties. This fact had been noticed at Coimbatore earlier when a number of rice varieties was studied histologically. I am glad that the Coimbatore findings are being confirmed by the authors. Since the results obtained at Coimbatore were originally published in the annual station report which is not usually available to the public, they are reproduced here.

The bran layer which contains the nutritive principles in rice and which usually gets removed with polishing, consists of the pericarp and some aleurone layers. The thickness of the bran layer is found to be not uniform all round the grain. It is somewhat thicker on the dorsal side of the grain (towards the palea) than on the ventral side. The table below gives the thickness of the layer on the two sides for 23 varieties of rice whose grain sections were examined under the microscope. The table also gives information about the colour of the bran layer in the rices examined and their classification into coarse, medium or fine. While it is evident that the coloured rices do generally contain a thicker bran layer some of the white rices also are found to possess this characteristic.

Variety	Grain size (coarse, fine, etc.)	Thickness of bran layer in microns (Pericarp + Aleurone)		Rice colour
		Dorsal side	Ventral side	
Black Puttu	Coarse	62·3	40·5	Purple
T. 303	do	53·3	37·4	White
T. 326	do	54·1	32·8	do
T. 88	do	48·8	32·1	Gr. Brown
T. 219	do	50·1	30·6	White
Co. 4	do	48·1	28·5	do
T. 29	do	52·8	39·3	Red
T. 248	do	44·1	38·3	do
T. 375	do	41·0	31·3	do
T. 73	Medium	54·8	33·8	do
T. 132	do	56·6	39·1	Brown
Co. 6	do	43·8	28·8	White
Co. 5	do	44·5	30·3	do
Co. 7	do	41·8	31·6	do
Co. 2	do	47·8	28·8	do
T. 218 (Adt. 4)	do	36·8	21·3	do
T. 217 (Adt. 3)	do	36·0	22·0	do
Co. 3	do	34·3	22·0	do
Co. 1	Medium Fine	42·3	25·8	do
T. 2	Fine	42·6	25·6	do
T. 124	do	47·1	27·3	do
T. 109	do	37·8	24·8	do
GEB. 24	do	35·3	26·1	do

[1] *Curr. Sci.*, 1936, **5**, 75.

K. RAMIAH.

Agricultural Department,
Coimbatore,
August 29, 1936.

REVIEWS.

Insulin—Its Production, Purification and Physiological Action. By Douglas W. Hill and Federick O. Howitt. (Hutchinson's Scientific and Technical Publications.) 1936. Pp. xi + 219. 12*s.* 6*d.* net.

"The discovery of insulin," as Prof. E. C. Dodds rightly observes in a foreword to this book, "can be described as one of the most important and dramatic events of the present century." The classical experiments of von Mering and Minkowski connecting the pancreas with the normal maintenance of the blood-sugar level had their culmination, after many failures, in the successful preparation of an active extract of the pancreas in the Toronto laboratories. This story, which is now well known, has been traced historically in this book and the chemical and physiological information concerning insulin has been brought very readably and exhaustively up-to-date. Clinical reviews have been omitted, the more strictly scientific aspects of the insulin problem being dealt with.

The book is highly informative concerning the methods of isolation of the hormone; the physical, chemical and physiological properties; the mechanism of its action; standardisation; possible substitutes of insulin, both synthetic and obtained from natural vegetable sources. As the authors state, the monograph is mainly meant for the specialist and there is a wealth of original references at the end of each chapter, which should be eminently helpful to those who wish to consult the sources. Although a vast amount of work has been done on various aspects of insulin, the insulin problem is far from being solved and one should be able to find indications in the book of profitable lines of study.

The book is printed in modern style and there are some beautiful photomicrographs. It also appears to be remarkably free from errors. The book will doubtless benefit not only those who are engaged on this subject but also workers on other biochemical problems, as it is not unoften that in biochemistry, in particular, results obtained in one field of study have unexpected and important implications in another.

B. C. G.

Sulphuric Acid Manufacture. By Andrew M. Fairile. (American Chemical Society Monograph No. 69.) (Chapman & Hall Ltd., London; Reinhold Publishing Corporation, N. Y.) 1936. Pp. 672. 48*s.* 6*d.* net.

There have been few books in the English language which attempt to bring within the compass of a single handy volume, an authoritative compilation on the modern methods in sulphuric acid manufacture. It is a very big task to sift from a mass of detail the more outstanding developments. The author, in our opinion, has achieved remarkable success with comparatively few shortcomings. The book describes both the Chamber and Contact processes as practised in various countries and deals in some detail with a number of important improvements in the industry which have been developed and placed on a working basis within the last decade. Though the author apparently shows a bias in favour of modern American practices by describing them in greater detail, it should be conceded it is done fairly. Modern American practice in the contact processes should be acknowledged as ahead of all other processes in different countries in the number of outstanding achievements; the newer Brimstone contact plant including the new sulphur burners, sulphur spray nozzles for molten sulphur, sulphur fired steam boilers popularising the use of newer vanadium mass which is increasingly appreciated, self-contained heat exchange converter, etc., may be said to be due to American enterprise.

The liquid-cooled chambers of the new Mills-Packard and Gaillard-Parrish's types and new tower process are also described with up-to-date details of equipment and methods of operation. There is also an interesting chapter on choice of process and trends in the industry. The future of the

sulphuric acid industry cannot but present an intriguing problem; definite tendencies are already somewhat looming on the horizon which are likely to reduce somewhat the importance of sulphuric acid as a basic chemical in heavy chemical industry.

A number of pages have been filled with some details of the famous Seldon-mansanto dispute on the vanadium contact mass which, though interesting, are, we feel, rather out of place and may well have been avoided as they increase the bulk of the book. Apart from this, the book is, in our opinion, well worth a place in the library of all chemists interested in chemical technology. It is an American Chemical Society Monograph and needless to mention is of excellent get-up. The price, however, appears to be rather on the high side.

B. H. K.

The New Acoustics. By N. W. Mc Lachlan. (Oxford University Press, London.) 1936. Pp. vi + 166. 7*s.* 6*d.*

The study of Acoustics has so far been made from a practical standpoint and much has to be done by way of theory to explain the practical observations.

From the above view-point, the subject has been treated by the author in a practical manner describing the various developments from the little known acoustic engineering of the 19th century down to the present date.

The chapters on loud-speakers are dealt with at great length with special attention for the assistance to the designer.

It is interesting to note that the mechanical systems of the devices such as microphones, pick-ups, sound box, loud-speakers, etc., are transformed into corresponding electrical analogue. The treatment of the subject is thereby rendered easy as the phenomena of the electrical circuits are well known. Perhaps this is the only way in which one can study acoustics analytically.

Just as the individual devices (pick-up, microphone, etc.) are dealt with at length in the book, the problem of acoustics in the design of talkie houses, motion picture studios, lecture halls, gramophone recording studios, broadcasting studios, etc., is not treated in detail. The reverberation properties or the absorption conditions of such buildings are facing the present-day designer. It is hoped that more detailed figures on these subjects will be available before the second edition of the book appears.

Differential Equations in Applied Chemistry. By F. L. Hitchcock and C. S. Robinson. (Chapman and Hall, Ltd., London.) Second Edition, Revised and enlarged, 1936. Pp. viii + 120. 7*s.* 6*d.*

In six interesting and well written chapters the authors have set upon themselves the task of teaching mathematics to Chemists and Chemical Engineers. The scope of the book and the concept of Calculus are put forth in popular language in the first chapter. The next three chapters deal with the processes of the first order, the second order and the simultaneous processes usually met with in Physical Chemistry. A proper emphasis has been given to graphical and numerical work. The use of semi-log property, and finding the best line through a set of points, which are usually not easy for a beginner are clearly discussed. The last two chapters are the most important ones for the Chemical Engineer. Chapter V treats of the principle of extraction, intermittent and continuous.

One excellence of this book is the happy choice of the problems at the end of each chapter and the miscellaneous examples at the end of the book. It appears that throughout, the requirements of the Chemical Engineer are constantly kept in view. The subjects treated in these problems comprise a variety of unit processes like flow of fluids, air conditioning and ventilation, drying, crushing, extraction, adsorption, heat transfer, filtration, desalting of hides, etc.

The book is to be warmly recommended to every student of Chemical Engineering.

B. S. SRIKANTAN.

Chapters in Organic Chemistry. By S. V. Divekar. (The Standard Publishing Co., Bombay.) First Edition, 1936. Pp. xxxv + 478. Price Rs. 7–8–0.

This book is intended to help the students studying mainly for the B.Sc. Examination of the Bombay University and is expected to be useful also for students preparing for similar examinations. It is not intended to replace any text-book but is meant to avoid the difficulties which the students have to

take to refer to several standard text-books and Journals. Chapters are devoted for the following topics :—

Purines, Heterocyclic compounds, Indigo, Alkaloids, Terpenes, Diketones, Polymethylenes, Carbohydrates, Enzymes, Plant pigments, Tannins, Organo-metallic compounds, Orientation, Determination of Structure, Reagents in Organic Chemistry, Reactions, preparation of 20 compounds of commercial importance.

Such a compilation will no doubt be popular amongst students preparing for examinations but will deprive the students of the necessary training they must have in referring to standard works and Journals. Some of the chapters have been dealt with in detail and will be useful for students preparing for the Honours course in Chemistry.

A chapter on stereo chemistry might have been added to the great advantage of the students. References to original papers would have helped the students desirous of getting more detailed information. The printing, get-up and binding are satisfactory.

H. S. J.

Protozoa-Ciliophora. By B. L. Bhatia, *Fauna of British India Series* (London, Aug. 1936).

The pioneer researches on Indian Protozoa were carried out by Dr. H. J. Carter of the Medical Service of the East India Company, who during the years 1856–1869 published a series of papers on the Infusoria of the island of Bombay in the *Annals and Magazine of Natural History.* Since this date work of a more or less sporadic nature has been carried out in different parts of India, and a detailed summary of it is given on pp. 10–12 of the Introduction of the volume under review.

The author has followed the latest classification and nomenclature of Protozoa and has, therefore, adopted the term Ciliophora (Doflein) including the classes Ciliata and Suctoria for the subphylum which is dealt with in his volume. In a fairly comprehensive introduction the author deals with the position of Ciliophora in the animal kingdom, a history of the study of the group in India, its classification and phylogeny, the geographical distribution of the free-living Indian forms and distribution with hosts of the parasitic forms, and in a final chapter are included details regarding the technique that should be followed for the study of these interesting but rather difficult animalcules. In the work 310 species belonging to no less than 104 genera are described. The descriptions of 68 species of 48 genera, of which one genus and 16 species are new to science, are the result of the author's researches. In the systematic account the author has given sufficiently detailed descriptions and keys for the identification of all families, even though several of them are not represented in India. This account would materially help in future work, as there is every likelihood of many more forms being discovered when more extended work is carried out in different parts of the country.

The author has been working on Protozoa for over 20 years and was, therefore, in a particularly happy position to deal with this very difficult group. The volume will be a lasting tribute to the painstaking way in which the work has been carried out, and it is hoped that its publication will attract more workers to study these difficult forms. The work is copiously illustrated with 214 text-figures and 11 halftone plates, and a bibliography of nearly 50 pages shows how scattered is the literature on these interesting animalcules. Both the author and the editor deserve the thanks of all workers in this country on the publication of this interesting volume.

B. P.

Outlines of General Zoölogy. Horatio H. Newman. (The Macmillan Company, New York.) 1936. Pp. 661 + xxvii. 15*s*.

The writer of this interesting treatise, the third edition of which we have received, was the director of a freshman survey course,—*The Nature of the World and of Man.* This attempt resulted in the birth at the University of Chicago of four main courses forming the essentials of the New Plan. So much so the *type method*, universally adopted in teaching institutions, is considerably improved and the book based upon this New Plan system commences by discussing in the first few pages, problems connected with life, protoplasm and the cell; then a discussion of types from amœba to frog and finally the general biological

principles follow. The book is divided into six parts and they are: (1) Biological Science and its History; (2) General Biological Principles; (3) Representative Animal Types (Invertebrates); (4) The Phylum Chordata; (5) Biological Mechanisms in General and Mechanisms of Individual Maintenance and Adjustment; (6) Mechanisms of Racial Maintenance and Adjustment (Evolution and Genetics).

At the end of each chapter, in all these six parts, there is a relevent summary. A bibliography and glossary make the book more useful.

The get-up of the book is excellent and we anticipate that in the next edition a chapter on modern experimental zoölogy will also be included. We recommend the book to every student and professor of zoölogy.

L. S. R.

An Index of the Minor Forest Products of the British Empire. (Published for the Imperial Economic Committee, London, 1936. H. M. Stationery Office.) Pp. 116. 5*s*. net.

An influential and representative Sub-Committee of the Imperial Economic Committee has compiled, with the co-operation of the several governments concerned, this Index. *Minor Forest Products* are understood as "any product of the natural forest, other than timber and its derivatives." The material has been arranged under the following groups :—Drugs and Spices; Dyes; Essential Oils; Fibres; Gums and Resins; Oils and Oil-seeds; Tanning Materials; Miscellaneous. Against each commodity is mentioned its present export trade and future export potentialities. A well-arranged Bibliography which avowedly is indicative rather than exhaustive together with an alphabetical list of the commodities at the end of the volume make for easy reference.

So far as Indian minor forest products are concerned, the *Index* reveals that data relating to some of the important products exported to non-Empire countries are very incomplete. Thus, although the export of the Indian Kuth (Costus root) to China is considerable, no figures relating to this commodity are available. Similarly, no data apparently exist about Cashew Nut the export of which is a flourishing activity in the Konkan.

The inclusion of *Eucarya* Spp., *Osyris tenuifoliata*, *Santalum album* and *Santalum yasi* all under "Sandalwood oil," while making for comprehensiveness is not indicative of the widely varying properties, and the prices which these products fetch in the world markets. This is mentioned here not as a criticism but to convey an idea of the scope of the *Index* whose aim was merely to tabulate the results of a survey of the Empire minor forest products as a first step to promote their use and "to develop the trade in them between Empire countries". The Committee thus set themselves a well-defined and limited task. The *Index* completely answers this purpose and should be of use to those interested in the utilisation of Empire minor forest products.

EMMENNAR.

Magnétisme et Electricité Terrestres. Par Ch. Maurain. Fascicule I—Magnétisme Terrestre. (No. 287 of Actualités Scientifiques et Industrielles. Hermann et Cie, Paris.) 1935. Pp. 63. 15 *fr*.

The projected fitting out of the non-magnetic ship "Research" to replace the "Carnegie" lost in 1929 demonstrates the importance attached to observations of terrestrial magnetism and electricity. The book before us is an authoritative resumé of the subject of terrestrial magnetism with references to telluric currents and polar auroras which are all closely interrelated, and is written by a savant who has devoted most of his time to improving our knowledge of the subject. The account is clear, balanced and impartial, qualities which are even more welcome in a field where so many partially successful theories are competing for mastery. The book may unreservedly be recommended to all those who wish to acquire a correct perspective of an important subject.

Statistical Research Memoirs. Vol. I. Edited by J. Neyman and E. S. Pearson. (Cambridge University Press.) 1936. Pp. 161. 15*s*.

This is the first of a new series of memoirs which will contain papers prepared in the Department of Statistics of the London University. The ambition of this department is "to contribute towards the establishment of a theory of statistics on a level

of accuracy which is usual in other branches of mathematics." The present volume is aptly dedicated to the memory of the late Professor Karl Pearson (1857–1936) who was one of the most outstanding personalities in the development of mathematical statistics. The memoirs will be edited by Professors J. Neyman and E. S. Pearson. The printing and get-up (by the Cambridge University Press) are beautiful.

In conformity with the expressed ambition of the department, the papers published in this volume mostly relate to the theory of testing statistical hypotheses—a subject which is being studied at great length in recent years by J. Neyman and E. S. Pearson as well as by other writers. The following brief introductions of some of the papers will indicate their scope.

(1) "Contributions to the Theory of Testing Statistical Hypotheses, I." By J. Neyman and E. S. Pearson.

Let $x_1, x_2, \ldots x_n$ be the observed system of variables, and let them be represented by a point E in n-dimensional space W. Let $P(E \epsilon w)$ denote the probability that the point E falls inside the region w of W. Any assumption concerning the nature of P is called a statistical hypothesis. We assume that a function $p(x_1, \ldots x_n) = p(E)$ exists which is positive and continuous in almost any point of W such that $\int_w p(E) = P\{E \epsilon w\}$. Any test of a statistical hypothesis H_0 may be considered as equivalent to a rule of rejecting H_0 whenever the sample point E falls within a certain "critical region" w and in accepting it in all other cases. The probability of the first kind of error determined by H_0 is the size of the corresponding critical region w. The probability of rejecting H_0 when an alternative H' is true has been termed the power of the test with regard to H' The most powerful test for H_0 with respect to H' is the test whose power is greater than that of any other equivalent test, and the critical region associated with this test has been termed the best critical region w_0 for H_0 w.r.t. H'. If w_0 is independent of the alternative hypothesis H', the test H_0 is called a "uniformly most powerful test". A theory based on these definitions has been developed in the authors' papers elsewhere. The present paper discusses cases where a solution along these lines is not possible—cases where it is not possible to find a single region which minimises the risk of accepting H_0 falsely whatever alternative H' be true. The problem of determining "unbiassed critical regions" for such cases, forms the central theme of the paper.

(2) "An investigation into the application of Neyman and Pearson's L_1 Test, with Tables of Percentage Limits." P. P. N. Nayer.

Let the observations of a variable quantity x fall into k groups and let x_{ti} be the ith observation in the t th group. If the populations are normal, the test H_1 that the k independent samples have been drawn from populations having the same S. D. σ is by considering the expression

$$L_1 = \frac{\left[\pi_t \left\{\sum_i \left(x_{ti} - \bar{x}_t\right)^2\right\}^{n_t}\right]^{1/N}}{\sum_t \sum_i \left(x_{ti} - \bar{x}_t\right)^2} \times \pi_t \left(\frac{n}{n_t}\right)^{n_t/N}$$

with the usual symbology. The hypothesis H_1 requires that L_1 (which lies between 0 and 1) is not very near to zero. Neyman and Pearson who have advanced this test expect that if H_1 is true, the sampling distribution of L_1 may be approximately represented by a Pearsonian curve of Type I:

$$p(L_1) = \frac{\Gamma(m_1 + m_2)}{\Gamma(m_1)\,\Gamma(m_2)} L_1^{m_1 - 1} \quad (1 - L_1)^{m_2 - 1}$$

The adequacy of this approximation is studied in some detail in the present paper, and tables of 5% and 1% probability levels for L_1 are given when n_t is constant.

(3) "Tests of Certain Linear Hypotheses and Their Application to Some Educational Problems." Palmer, O. Johnson and J. Neyman.

Following the general ideas of testing hypotheses developed by Neyman and Pearson, and of St. Kolodziejczyk's test for "linear" statistical hypotheses the authors discuss a broad class of educational problems which can be reduced to those of testing linear statistical hypotheses.

(4) "On the Analysis of k Samples from Exponential Populations with Especial Reference to the Problem of Random Intervals." P. V. Sukhatme.

If a series of events occur randomly in time (or space) the frequency of these events occurring in a given interval of time (or space) follow a Poisson distribution. A second method of attack to examine the random occurrence of the events is based on the analysis of the intervals between the

events occurring at random. The present paper explains how tests may be developed based on the distribution of intervals between random events, analogous to the "Analysis of Variance" tests of R. A. Fisher for the case of normal law variation. The methods are illustrated by telephone and accident data.

(5) "Tests of Statistical Hypotheses in the Case when the Set of Alternatives is Discontinuous, illustrated on some Genetical Problems." Robert W. B. Jackson.

Let H_0 be a simple hypothesis to be tested, Ω the test of simple hypotheses which are considered admissible. Following the notations of papers on this subject, the set Ω is defined as continuous if whatever the hypothesis H_0 belonging to Ω, whatever the region w in the sample space, and whatever $\alpha > 0$, it is possible to find within Ω another hypothesis H_1 different from H_0 such that

$$| P\{E \epsilon w \mid H_0\} - P\{E \epsilon w \mid H_1\} | < \alpha.$$

The theory of testing statistical hypotheses so far developed applies mainly to the case where Ω is continuous. When the set of admissible hypotheses is discontinuous, a test called the most stringent test has been developed in this paper, based on the consideration of the total probability of errors of all kinds involved in the testing.

C. N. S.

The Mathematics Student. Vol. IV, No. 1. (Published by the Indian Mathematical Society.)

This number is mainly devoted to the Proceedings of the Ninth Conference of the Indian Mathematical Society, held at Delhi in December 1935. The address of welcome by Rai Bahadur Ram Kishore, the opening speech by Sir Girja Shankar Bajpai, the Presidential Address by Dr. R. Vaidyanathaswamy, and the substance of a public lecture on Cosmography by Prof. A. C. Banerji, are printed in full. The Presidential Address on "Mathematics and Modern Physics" discusses the mathematical concepts of "Group" and "Eigen-value" with reference to physical problems, and will be well appreciated as coming from a talented thinker. One sentence which deserves to be quoted is the following: "The whole theory of Eigen-values may be regarded as the generalisation of the idea behind the theorem that an ellipsoid has always three mutually perpendicular principal axes, or in more general form, two conics have in general a unique common self-polar triangle."

A paper "On Quadratic Equations" by Prof. A. Narasinga Rao concludes the present number. The following explains the gist of this paper:

A (1, 1) correspondence is set up between quadratic equations and points of a plane by taking (a_0, a_1, a_2), the homogeneous coordinates of a point correspond to the equation $a_0 x^2 - 2a_1 x + a_2 = 0$. The points of the conic $\Omega \equiv xz - y^2 = 0$ correspond to equations with equal roots. Then it follows that conjugate points *w. r. t.* Ω correspond to a polar quadratics, and all quadratics with a common root t correspond to points on the tangent to Ω at t.

A very interesting method of proof to show that generators of the same system on a quadric in [3] do not intersect while generators of opposite systems intersect is given by what the author calls as the "Lie representation" of oriented quadratic equations. If t_1 and t_2 are the roots taken in a certain order, of $a_0 t^2 - 2a_1 t + a_2 = 0$, consider the point (a_0, a_1, a_2, a_3) in 3-space, where $a_3 = a_0 (t_1 - t_2)$. This point lies on the quadric surface $a_3{}^2 = 4(a_1{}^2 - a_0 a_2)$. The quadric with roots t_2 and t_1 is then represented by $(a_0, a_1, a_2, -a_3)$. In terms of (t_1, t_2), the point (a_0, a_1, a_2, a_3) may be written $1, \frac{1}{2}(t_1 + t_2), t_1 t_2, t_1 - t_2$. Hence equations with $t_1 =$ constant, correspond to one system of generators while equations with $t_2 =$ constant correspond to the opposite system of generators.

These concepts are briefly extended to cubic equations, oriented and non-oriented.

C. N. S.

Laterite.*

DURING the last few years, the question of the exact character and mode of origin of Laterite has come in for a lot of comment by geologists both in India and abroad. The term 'laterite' was first used by Dr. Francis Buchanan, so far back as about 1800; and for more than a century now this term has been so commonly employed by a number of field geologists in describing certain deposits in different parts of India, that one often wonders whether all these 'laterites' of different authors are really the same kind of material, both in constitution and mode of formation. From a perusal of the literature, it was obvious that the term had been often loosely employed, with the result that in any discussion of the nature of laterite in general, there was ample room for confusion and controversy. Geologists were thus not quite happy concerning the nomenclature of laterite and many of them naturally felt that for any useful or profitable discussion of problems connected with laterite, it was desirable to have, at the outset, an exact account of Buchanan's original laterite from his type areas in Malabar. This work Dr. Fox undertook in November 1933 and the result is the 'informing and authoritative' paper which has just been published by him on Buchanan's Laterite of Malabar and Kanara.

In this paper Dr. Fox has, to begin with, given a number of extracts from Buchanan's descriptions to give us an idea of what exactly he (Dr. Buchanan) was thinking of when he used the term laterite. All the laterite occurrences in Malabar, Kanara and Shimoga are associated with granitic rocks below, and are seen to pass down into them through a zone of kaolinised rock. There is thus no doubt that the laterite has been formed from such acid rocks. It is not possible to say in the field whether this vermicular soft laterite contains hydrated alumina or hydrous silicate of alumina. Since it is clearly on this point that the whole modern nomenclature depends, a few typical samples were immediately analysed. The results obtained were extraordinarily surprising. From these analyses it was evident that Buchanan's 'Laterite' is really a vermicular lithomarge, with a considerable amount of ferric hydrate present in the upper part—and is not a true laterite according to the generally accepted sense of the term as representing "an earthy residuum of aluminium trihydrate (in its crystalline form of gibbsite), limonite, a few unaltered fragments of felspars, in some cases secondary quartz, and the various resistant minerals originally present in the rock."[1] According to J. B. Scrivenor[2] the formation of laterite and the process called 'lateritisation' consist "in the formation of aluminium hydrate from silicates as an end-product of weathering instead of hydrated silicate, which is regarded as the usual end-product of weathering in temperate climes. The theory is that in tropical regions, the hydrated silicate is formed, but undergoes further decomposition, whereby the silica is removed in solution and aluminium hydrate remains." Thus the term 'Lateritisation' refers to an end process of weathering beyond that of kaolinisation, whereby the hydrated silicates break down into the hydroxides of alumina which remain and silica which is removed in solution; and it is thus obvious that in nature, there can be rocks representing every stage in this process from the formation of kaolin or lithomarge to the final condition practically devoid of silica, and with aluminium hydroxide and ferric hydrate as the two essential components—a condition nowhere fulfilled by Buchanan's laterite. From Dr. Fox's studies it is clear that Buchanan's original laterite in his type area, consists mainly of what we should now call 'lithomargic laterite' or even 'lateritic lithomarge' which marks only an earlier stage in any process of true 'lateritisation'.

This important conclusion arrived at by Dr. Fox is of great value since it clarifies our position in all future discussions bearing on laterites, and his present paper will be welcomed by all geologists, both in India and abroad, as an authoritative and masterly contribution leading to a clear and proper understanding of the exact character of laterites in general.

L. RAMA RAO.

* C. S. Fox, "Buchanan's Laterite of Malabar and Kanara," *Rec. Geol. Surv. Ind.*, **69**, Pt. 4.

[1] Sir John Harrison, "The Katamorphism of Igneous Rocks under Tropical Conditions," *Imp. Bur. of Soil Sci. Eng.*, 1934.

[2] J. B. Scrivenor, *The Geology of Malaya*, 1931.

OBITUARY.

Dr. Arthur Henderson Mackenzie, M.A., D.Litt., C.I.E., C.S.I.

Dr. Arthur Henderson Mackenzie, late of Hyderabad, died on Saturday, the 26th September 1936, at the age of 56. He was born in February 1880 and received his University Education at Aberdeen. He came over to India in 1908, as Inspector of Schools in the United Provinces. He successively held a series of responsible posts, Principal, Training College, Allahabad (1909–1920), Chief Inspector of Vernacular Education, U.P. (1920–21) and Director of Public Instruction, U.P. (1921–1934). He then left U.P., where he had spent 26 years, to take up the appointment of Pro-Vice-Chancellor of the Osmania University. Dr. Mackenzie was appointed Education Commissioner with the Government of India, in which capacity he had officiated for one year in 1930, but ill-health prevented him from accepting the appointment. He was decorated with the C.I.E. in 1928 and with the C.S.I. in 1933.

Dr. Mackenzie was responsible for the proposals of reorganisation of education in Hyderabad, resulting from the appointment of an enquiry committee known as the Mackenzie Committee. He was a member of the Quinquennial Reviewing Committee of the Indian Institute of Science, which was appointed by the Government of India to review the working of the Institute with Sir James Irvine as Chairman. His death will be a severe loss to his numerous friends.

CENTENARIES.

S. R. Ranganathan, M.A., L.T., F.L.S.

Shippen, William (1736–1808).

William Shippen, the pioneer anatomy teacher of the New World, was born in Philadelphia on October 21, 1736. His father was one of the prominent medical men of his day. Having graduated at the College of New Jersey in 1754, he studied medicine under his father till 1757. In those days, there was no regular medical college in America. The youth of that period, destined to a medical career, was at an early age indentured to some reputable practitioner, to whom his service was successively menial, pharmaceutical and professional. Ambitious spirits, seeking to have a more assured and inspiring discipline, resorted to the hospitals and lecture halls of Leyden, Paris, London and Edinburgh. William Shippen was one of the first such men. He crossed the Atlantic in 1757. He studied in London chiefly under William Hunter and Colin McKenzie and received much help from John Fathergill. In 1761 he received the M.D. of Edinburgh and later visited the chief medical schools of France.

Is Mobbed for Dissecting.

Shippen was one of the pioneering type of eighteenth century American youths, who, on returning to their native land, sought opportunities to share with their less fortunate or less adventurous fellows the rich experience gained as they "walked the hospitals" of the Old World. The voices of the great European masters of that day thus re-echoed in the New World. High scientific and professional ideals impelled these youthful enthusiasts, who bore their lighted torches safely back across the waters. In 1762, the very year of return, Shippen began a course of lectures on midwifery. In the following autumn, he announced a series of anatomical lectures "for the advantage of the young gentlemen in this and neighbouring provinces, whose circumstances and connections will not admit of their going abroad for improvement to the anatomical schools of Europe, and also for the entertainment of any gentleman who may have the curiosity to understand the anatomy of the human frame." In this course, he introduced, for the first time in America, the dissection of human bodies as part of the instruction. This aroused the animosity of the populace. His dissecting rooms were mobbed on several occasions, and once he narrowly escaped with his life. Slowly the prejudice died out however and the number of students increased year by year.

Founds the First Medical School.

From these detached courses, the step to an organised medical school was taken in

collaboration with a friend and fellow-student abroad, John Morgan. The trustees of the college of Philadelphia were approached and in 1765 a medical school was established as part of the college and intimately connected with the Pennsylvania hospital, established thirteen years earlier through the efforts of Thomas Bond and Benjamin Franklin. William Shippen became the first professor of anatomy and surgery in this school, which was the first of its kind in America. The first batch of ten Bachelors of Medicine graduated from this school in 1768. When the legislature repealed the charter of the college of Philadelphia in 1779 and created the University of the State of Pennsylvania, he accepted the Chair in the new school. In 1791, when this University gave place to another University under the name of the University of Pennsylvania, he was again appointed Professor of Anatomy, Surgery and Midwifery.

His Influence.

Shippen was also one of the Founders of the College of Physicians of Philadelphia and he was its President from 1805 to 1808. Speaking at the centenary celebration of the College on the 3rd January 1887, Sir William Osler included Shippen among those who, by their reputation and service to medical science, belong not to Philadelphia alone but to the history of the profession. A more detailed and eloquent tribute was paid by Osler, ten years later, on the first of September 1897 in his address on "British Medicine in Greater Britain" at the meeting of the British Medical Association in Canada. Osler said, "A physician may possess the science of Harvey and the art of Sydenham and yet there may be lacking in him those finer qualities of heart and head which count for so much in life... Medicine is seen at its best in men whose faculties have had the highest and most harmonious culture..... And the men of this stamp in Greater Britain have left the most enduring mark—Beaumont Bovell.... Morgan, Shippen.... Brahmins all, in the language of the greatest Brahmin among them, Oliver Wendell Holmes—these and the men like unto them have been the leaven which has raised our profession above the dead level of business."

The End.

In 1798, occurred the death of the only son of Shippen a young man of great promise. After this, he seems to have lost interest in life. His health gradually declined, his practice fell off and he seldom lectured. He died at Philadelphia on the 11th July, 1808.

Lax, William (1761–1836).

William Lax, a British astronomer, was born in 1761. He had his University education at Trinity College, Cambridge. He graduated in 1785 as senior wrangler. He was also the first Smith's prizeman of his year. He was elected a Fellow of his college in 1788. William Lax succeeded Dr. Smith in 1795 as Lowndes's Professor of Astronomy and Geometry in the University of Cambridge. After some years of teaching work, he was presented by Trinity College to the livings of Mersworth, where he built a small observatory.

His Writings.

In 1807, he published his *Remarks on a Supposed Error in the Elements of Euclid.* The Board of Longitude published his *Tables to be used with the Nautical Almanac*—the first edition in 1821 and a second one in 1834. Two of his papers appear in the *Transactions* of the Royal Society of London: *A method of finding the latitude of a place by means of two altitudes of the sun* (1799) and *On a method of examining the divisions of astronomical instruments* (1808). The method proposed by Mr. Lax in the latter paper, though very ingenious, required great labour and time and was pronounced to be inferior in accuracy and efficiency to that proposed by Troughton in the same volume of the *Transactions*.

He died on the 29th October 1836, at the age of 75.

Hough, George Washington (1836–1909).

G. W. Hough, the American astronomer, was born on October 24, 1836, at Tribes Hill, New York. He was descended from German ancestors who migrated from Würtemburg in 1730. He is said to have inherited a mechanical genius from his father. Two early evidences of this are recorded. They both relate to his ninth year. It would appear he harnessed up a small brook to run his mother's churn, and

that he constructed a contrivance from fish poles for measuring the right ascension of a star. He graduated with high honours at New York in his 20th year. After being a teacher for a couple of years, he entered Harvard University and obtained the Master's Degree in 1859.

CAREER AS ASTRONOMER.

In the same year, he became an assistant astronomer under O. M. Mitchel at the Cincinnati Observatory. Next year he went with his chief to the Dodley Observatory at Albany. Two years later, *i.e.*, 1862, he succeeded his chief and continued as Director till 1874. At this time, there was a break from astronomy to commercial pursuits for five years. Then, in 1879, he resumed astronomy as Director of the Dearborn Observatory which was first at Chicago and then at Evanston. He kept to this post till his death. Throughout this long period of thirty years, he was also Professor of Astronomy, first at the Chicago University and later at the North Western University.

HIS CONTRIBUTIONS TO METEOROLOGY.

While at Dudley, his time was largely devoted to meteorological work, although he did some astronomical work such as the observations of the declination of stars, observations of Neptune, of asteroids, etc. It was during the fourteen years of residence in Albany that he invented his printing barometer, his self-recording thermometer, his printing chronograph and his anemograph. His printing barometer won for him a Gold Medal at the Centennial Exhibition in Philadelphia in 1876 and at the World's Fair in Chicago in 1893. During his Dudley period, he also led a total solar expedition to Matoon in 1869.

HIS CONTRIBUTIONS TO ASTRONOMY.

Throughout the thirty years he was at the head of the Dearborn Observatory, his output of astronomical work was unceasing. Almost in the first year, he commenced the study of the planet Jupiter, which he continued up to his death. The *Annual Reports* of the Chicago Astronomical Society contain a mass of his micrometric studies of all the jovian phenomena especially of the great red spot and the equatorial belts, the value of which is greatly enhanced in that they were made by *one* man throughout a period of thirty years. Another field in which he distinguished himself during this period is that of double stars. With the 18½-inch refracter of Professor Burnham, he measured a large number of double stars and discovered no less than 648. Among the discoverers of double stars he ranks fourth, the other three being Burnham, Aitken and Hussey. Out of more than 10,000 double stars studied, only one is known which is of as short a period as Hough's No. 212 (13 ceti). His work on double stars have been collected by Prof. Doolittle in Volume 3, part 3 of the *Publications of the University of Pennsylvania.* On the instrumental side, his chief invention of this period is the moving dome and adjustable observer's chair, which have been widely adopted by other observatories.

HIS HONOURS.

Reference has already been made to the recognition which his printing barometer brought him. In 1891 he received the honorary degree of Doctor of Laws from Union College and got elected to the British Astronomical Association. In 1893, he was President of the Mathematics and Science section of the World's Congress in Chicago. In 1903, he was elected an Associate Member of the Royal Astronomical Society of England. He was also a member of about ten other learned societies and a Vice-President of the American Association for the Advancement of Science. He was considered an outstanding authority on all matters connected with Jupiter.

Sham and ostentation were foreign to his nature. In character, he is said to have been of a quiet and unassuming but of an affectionate, genial disposition. His learning and knowledge were vast and very wide in their scope. He never spoke hastily nor too much, and his opinion on a subject was always worth having.

Death came suddenly and painlessly to him on the New Year's morning of 1909, at about ten o'clock.

RESEARCH NOTES.

BIOLOGICAL.

Ascorbic Acid and Glutathione.—The relation between ascorbic acid and glutathione, first recognised by Szent-Györgyi and since assuming great importance as one of the possible factors in the physiological rôle of the vitamin, has been established clearly now by Hopkins and Morgan (*Biochem. J.*, 1936, **30**, 1446–1461). They find that such a relation between these two biologically important compounds is brought about through the intermediary of hexoxidase (ascorbic acid oxidase), which, while being specific for ascorbic acid when alone, and therefore by itself without action on pure glutathione, however oxidises the tripeptide in presence of the specific substrate. Hence in the system ascorbic acid—oxidase-glutathione, the oxidation of ascorbic acid by its oxidase commences and proceeds normally only after all the glutathione in the system has been oxidised. Under anærobic conditions this oxidation of glutathione by oxidised ascorbic acid + oxidase is very much faster than under ærobic conditions in the presence of the enzyme. Thus this oxidase seems to be more energetic to activate oxidised ascorbic acid as an hydrogen acceptor for glutathione, than to activate reduced ascorbic acid as a hydrogen donator for oxygen. In effect, glutathione apparently protects ascorbic acid from being oxidised by its specific enzyme.

Actually, however, glutathione does afford, a protection to ascorbic acid from oxidation catalysed by copper, thus explaining the now well-known capacity of the copper-containing hepatic tissues to inhibit autoxidation of ascorbic acid.

Insulin and Glucagon.—Professor Max Burger of Bonn and co-workers who succeeded in preparing Insulin in a pure crystalline form, have been comparing the physiological action of the crystalline substance with that of the common "Insulin" of commerce. The investigation has yielded results, some of them unexpected, which are recorded in *Forschungen und Fortschritte* (1936, 12, 308). While the commercial Insulin causes on administration first a primary increase in the blood-sugar content (followed, of course, by a secondary and more than corresponding diminution), the pure crystalline substance did not produce the primary increase. Further work showed that the peculiar action of the commercial Insulin was directly traceable to Glucagon, a substance present in pancreas. Glucagon has the closest resemblance to Insulin, both being protein-like bodies with practically identical C, H, N and S contents. But Glucagon has a reduction value slightly lower than that of pure Insulin, is adialysable and is adsorbed by a variety of media. Its potency, unlike that of pure Insulin, is not affected by salt solutions and by cystine. The purest specimens of Glucagon which Prof. Burger could prepare raised the blood-sugar content, on injection to normal rabbits in a dosage of 20 γ/Kg., by nearly 50 % of the original value for a period of 40 to 60 minutes. It was also found that most of the commercial samples of Insulin examined contained, in addition to Glucagon, traces of other substances which are presumably responsible for the skin maladies which are occasionally met with in the application of Insulin therapy. The standardisation of Insulin dosage is, therefore, not so simple as it was first thought to be. Expressing the physiological strength of Insulin as the product of its sugar diminution capacity ("depth" of action as Prof. Burger calls it) and the period during which its action is effective, it is found that crystallised Insulin has about double the strength of the international standard Insulin.

Further work has shown that the physiological action of crystalline Insulin is not confined to the carbohydrate economy of the body. The synthesis of fats in the organism is increased and the oxidation processes are accelerated. Prof. Burger's work, in addition to having materially contributed to our knowledge of the properties of pure Insulin, has rendered a more precise standardisation of the substance possible.

EMMENNAR.

Pollen Grains of Angiosperms.—The study of a large number of species has enabled Geitler (*Planta*, 1935, **24**, 361–386) to confirm Goebel's opinion that the pollen grains of Angiosperms have a polarity which is related to their position within the tetrad. But, while Goebel thought that the generative cell is always cut off towards the outer wall of the tetrad, Geitler has shown that other positions (towards the centre of the tetrad, or laterally on the radial walls) also occur. The place of formation of the generative cell is constant for each species, but it may vary in related genera: for instance, in *Vaccinium vitis idæa* it is on the outer wall, while in *Erica persoluta* it is towards the centre of the tetrad.

It appears that there is no relation between the method of division of the pollen-mother cells (simultaneous or successive) and the position of the young generative cell. It is only the plasm of the grain, which is responsible for transporting the nucleus to its distinctive place of division and for forming vacuoles at other places. It is also probable that the distinctive direction of the spindle may be due to a polarity of the microspore nucleus itself.

Some of the author's observations on chromosome behaviour also seem to be of great value. Especially interesting is the statement that during metakinesis there is not only a movement of the attachment constrictions to the equator, but that the chromosomes themselves make autonomous movements within the plate so as to attain a radial arrangement, or, when there is less space (as in *Gasteria*), a similar constant position of the long chromosomes. Likewise, in the early telophase also, the chromosomes (especially the long ones) were observed in such positions which tended to bring their distal ends into the nuclear space and gave the impression of autonomous movement.

H. D. WULFF.

Indian Museums.

By E. A. D'abrew.
(*Central Museum, Nagpur.*)

MOST provinces in India have their museums but it is regrettable how very few of these museums have developed a provincial aspect, which should be the foremost thought in their system of development.

Recently there has been a tendency to develop archæology only in these museums to the detriment of other branches and sections. Archæological museums are certainly the easiest to curate whilst biological ones are the most difficult. As archæologists or numismatists are frequently in charge of such institutions, it is natural that natural history and other sections will suffer, although the latter are more popular with the general public.

I visited the Lucknow Museum many years ago and was rather struck by the richness of its natural history collections which only required proper arrangement and labelling to make it into a really good show as many good specimens were already there. Twenty years later, I visited this same museum and found that most, if not all the biological collections had disappeared and had been replaced by other exhibits, among which the only ones of any interest were archæological.

The Lahore Museum is purely an art museum and, although I have not seen it myself, I am told it is badly ventilated and that the natural history section has disappeared long ago; yet the Punjab is extremely rich in animal life peculiar to itself.

I took a peep into the Patna Museum the other day. The building was an imposing structure and I anticipated seeing a horde of Asokan relics, perhaps a whole room devoted to old Pataliputra and Maurian art, but I was disappointed. A fine figure of a 'chauri' bearer, at the entrance was all I saw and though this was attributed to Asoka's age, the stone showed no signs of age and appeared as if recently carved. The natural history section contained practically nothing of local interest although the province of Bihar is rich in fauna, not to mention the fauna of the Ganges alone. A pair of Pink-headed Ducks were the only decent exhibits; the rest consisted of some local, exotic and domestic birds, mostly badly mounted with illegible or incorrect labels. A good bison head hung on the wall but one of its horns was completely destroyed by dermestid beetles. In this same room were also placed Tibetan head dresses, paints, paintings, sculptures, etc.

The Bombay Museum is perhaps the most up-to-date, particularly in its natural history section, but conditions here are different to what are available in most provincial museums. The natural history section is backed by a society of about 1,000 members interested in natural history, many of whom help in an honorary capacity and besides, the staff is better paid than in most museums.

One defect I found in most archæological museums is that they do not bring the subject home to the layman, nor are the collections arranged in a way to make the subject interesting and guide books are generally not available.

Nowadays most colleges teach biology but even an elementary display of zoological types are non-existent in most provincial museums. I once met a post-graduate student in zoology, who said his thesis had been on the moths of Lahore, yet this same student when shown a Uranid moth, pronounced it to be a butterfly !!

The complaint in most museums is lack of funds and mismanagement by those at the head through want of proper technical knowledge on the subject of museums. Sometimes a few persons who perhaps are uninterested and have never visited a museum are appointed to select a curator and of course the man with the highest degree amongst the applicants is selected, although he may be quite unsuited for the post. The result is that valuable collections already accumulated are lost or rejected before he gets initiated or learns his work.

Then again a person cannot be an expert in all the branches of a museum and it becomes necessary to have assistants for certain sections; this prevents neglect in sections in which the head of the museum is not much interested. A geologist for instance will hardly take an interest in ethnology or an archæologist in zoology and *vice versa*. It is here that the services, if available, of honorary workers, who are experts and keen on the subject, should be enlisted. Perhaps it would be better policy for one man to curate a certain section in two or more museums.

Another point which needs development in local museums are libraries, laboratories and research collections, which should be available to the public. There might also be an Inspector-General of Museums whose duty it would be to go round giving advice and suggestions.

Visits of the staff to other museums should be encouraged, as it may be useful in suggesting new ideas, and it should be open even to junior members of the staff as well as to directors and curators. Museum publications should be encouraged even if they do not profit the museum.

Lastly the man appointed to a museum should be an enthusiast and keen on his subject, and the keener he is the more the museum will improve unless his energies are damped by those above him or by financial stringency.

SCIENCE NOTES.

Need for Research in India on Intergeneric Crosses between *Brassica* and *Raphanus*.—Dr. R. H. Richharia, Agricultural Research Institute, Nagpur, writes :—

Some of our oil seed crops such as mustard and rape belong to the genus *Brassica*. The intergeneric crosses between this genus and *Raphanus* to which radish belongs have been of great interest in recent years especially in demonstrating the experimental production of new species and genera by hybridisation. They are important not only from purely scientific point of view but from economic view-point as well. The interesting Radish-cabbage hybrids, (Karpechenko, 1924–27; Richharia, 1936) Raphano-brassica, are well known (see photograph).[1,2,3] In F_2 from this cross, *Raphanus sativus* (Radish) × *Brassica oleracea* (Cabbage Brussels sprout, etc.) several types of polyploids originate, of which only tetraploids are very fertile and constant. These hybrids are quite huge and vigorous. Their leaves can be used as fodder and fruits as vegetables. During the year 1934–35 a few hybrids could withstand the extreme winter of England (Cambridge), thus were biennial. It is quite possible that under favourable climatic conditions they may be made perennial. In India the question is whether they will be able to survive through the hot season. Experiments from this point of view have been started on this experimental station.

a b

Fig. 1.—Fruits from Tetraploid Raphanobrassica (*Raphanus sativus* × *Brassica oleracea*).

(*a*) A single fruit. The upper half (nearly) is radish part and the lower, cabbage.

(*b*) A branch with feebly developed fruits.

Species such as *B. Carinata* (Abyssinian mustard), *B. chinensis*, etc., also easily cross with Radish (*e.g.*, Karpechenko, 1929; Tarasawa and Shimotomai, 1928; Tarasawa, 1933, etc.).[4,5,6] But F_1 generation in all these crosses is extremely sterile. Occasionally a few seeds may be obtained which in F_2 produce different types of polyploids. It is quite possible that if the different F_1's are grown under various controlled and natural environmental conditions important results may be obtained.

These crosses also open a very promising line of research from the bio-chemical point of view.

The purpose of the above note is to invite the attention, of scientific workers to the possibility of utilising intergeneric crosses between *Brassica* and *Raphanus* as experimental material.

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DR. T. S. WHEELER has returned from leave and resumed charge of office as Principal, Royal Institute (of) Bombay.

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A Note on a Few Rusts from Kolagaon (Nagar District).—Prof. S. A. Parandekar, Rajaram College, Kolhapur, writes :—

Rusts are so common in our fungus flora; by their coloured spots specially on the leaves that they are conspicuous enough to the "rust-collectors".

During a casual visit to Kolagaon (about 15 miles from Kopergaon Railway Station on Poona-Dhond-Manmad Line) in October last, the following three rusts were collected and identified; the identification was later confirmed by Dr. Sydow of Berlin. As these forms are not reported so far from the same locality, it was thought worth while to do so.

1. *Uromyces Aloes* (Cke.) P. Magn. on leaves of *Aloe vera* plants growing on the banks of the river "Umbri" and near by. In this case it was confirmed by observations that the fungus remains dormant during the hot weather and produces the spores in spring and winter on the leaves which apparently look healthy and the infection occurs immediately after the spores mature—a view already expressed with some doubt by Ajrekar and Tonapy,[1] who have reported the fungus previously from Talegaon (Poona District). The same rust is also reported previously from Coimbatore.[2]

2. *Puccinia heterospora* Berk and Curt. on *Sida spinosa* growing in large numbers in the vicinity of the P. W. D. bungalow; this is previously reported from Poona, Dharwar, Mysore and Berars.[2]

3. *Uromyces commelinæ* (Cke.) on *Commelina Forskalæi*, Vahl., Enum. growing on the bank of the irrigation canals (Godavari—Right Bank); this is previously reported on *Commelina benghalensis*, *C. obliqua* and *Cynotis* species elsewhere.[2]

* * *

Expedition to Mount Nanda Devi.—On August 29, the members of the Joint British-American Expedition led by Prof. Graham Brown climbed for the first time Nanda Devi, the highest peak (25,660 ft.) in the British Empire. The members of the Expedition consisting of seven experienced mountaineers, left Ranikhet on the first stage of the journey on July 14th. It was calculated that the party would take about three weeks to reach the base camp at the foot of the Naini Tal gorge.

According to an account published in *Statesman* (Sept. 13th) Messrs. Tillman and Eric Shipton first achieved in 1934 the feat of penetrating into the basin of Nanda Devi. According to Mr. Ruttledge "Nanda Devi is guarded by a 70-mile barrier-ring on which stand 12 measured peaks, over 21,000 feet high and which have no depression lower than 17,000 feet except in the west where the Rishi Ganga rising at the foot of Nanda Devi and draining an area of some 250

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[1] Karpechenko, *J. Genet.*, 1924, **14**, 375.

[2] Karpechenko, *Bull. App. Bot. and Plant Breeding*, 1927, **17**(3), 305.

[3] Richharia, R. H., *Cytological Investigation of* Raphanus sativus, Brassica oleracea *and their* F_1 *and* F_2 *hybrids.* (In press.)

[4] Karpechenko, *Proc. U.S.S.R. Congr. Genet.*, 1929, **2**, 277.

[5] Tarasawa and Shimotomai, *Abstr., Jap. J. Bot.*, 1928.

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[1] Ajrekar and Tonapy, *Journ. Ind. Bot. Soc.*, Sept.

sq. miles of ice and snow has carved for itself what must be one of the most terrific gorges in the world; two internal ridges converging from the north and south upon the river form the curtains of the inner sanctuary with which the great mountain soars up to 25,660 feet." This defence had previously defeated Dr. Longstaff, Dr. Sommervele, General Wilson and Mr. Hugh Ruttledge. Messrs. Tillman and Shipton entered and left the basin in 1934 by the Rishi Ganga and in the same year reached it again by the same route to emerge by the Sunderdhanga col and valley on the southern rim, after climbing a considerable distance up the south face of Nanda Devi herself.

The triumph of the Expedition is not a little due to the quick movement made possible by the light luggage with which they had provided themselves.

* * *

Siniolehu Conquered by German Climbers.—Yet another triumph of Himalayan Expedition was achieved by the German climbers on September 23rd, when the party led by Herr Paul Bauer reached the summit of Siniolehu (22,620 ft.). The summit was reached at 2 P.M. The last part of the climb from a height of 21,300 ft. up to the summit provided very difficult climbing. The expeditionists hope to climb some of the neighbouring hills.

* * *

North America's Highest Peak.—In a series of four flights from the Pan American Airways base at Fairbanks, Alaska, Mr. Bradford Washburn, leader of the National Geographic Society's Mt. McKinley Expedition, succeeded in photographing a vast expanse of the rugged terrain between Mt. McKinley and Mt. Hayes.

The pictures reveal the highest territory under the American flag. They also mark the first use, in the region, of infra-red ray photography, which makes it possible for the same photograph to show the town of Fairbanks and the white summits of Mt. McKinley and its related peaks projecting above the horizon more than a hundred miles away across a haze-obscured plain.

The infra-red photographs show why Mt. McKinley can claim one of the greatest heights, from top to bottom, among the world's mountains, since it rises 20,000 feet from a level plain almost without foothills. Mt. Everest although 29,000 feet above sea-level, actually rises only about 10,000 feet above a lofty plateau region. Because of its near Arctic latitude, Mt. McKinley has a very low timber line and is forbiddingly barren. Its expanses of snow and glacier do not completely cover all its jagged rocky ridges.

After flying 500 feet above the top of Mt. McKinley, despite dangerous air currents, and circling the peak several times Mr. Washburn flew straight along the axis of the mountains, taking close range photographs in pairs, stereoscopic fashion, at intervals of a minute. He thus obtained a progressive series showing the various peaks in their true relations to one another.

Photographs of Mt. McKinley reveal a giant of almost unrealizable magnitude massive to the very top. Its steeply sloping western face has been called the world's highest cliff—an almost sheer drop of over three miles. The southern side, however, is perhaps more impressive, although only about two miles deep, its wall is perpendicular. Only three expeditions have been known to scale Mt. McKinley.

South Indian Epigraphy.—The annual report for the South Indian Epigraphy for the year 1932–33 just issued, chronicles the activities of the special branch of the Archæological Department, interested in the decipherment of inscriptions discovered in South India. During the years an intense survey in selected parts of the Madras Presidency and Bombay—Karnatak was carried out; 600 inscriptions were copied in 133 villages, the actual number of villages inspected being over 350.

Several inscriptions refer to the Pallava Kings of Conjeevaram and these throw interesting sidelight on the ancient social customs and beliefs. The existence of several unknown kings of the Chanukya dynasty in the Northern Circars can be inferred from the inscriptions found in the Ganjam and Godavari Districts, and a revised genealogy of the Kona-Haihaya chiefs of the Andhra country has been given.

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State Aid to Industries.—A review of the efforts that have been made by the Government of India to stimulate industries, has been published as a *Bulletin* of the Industries and Labour Department of the Government of India. The review covering the period 1928–1935 has been prepared by Mr. N. Mahadeva Ayyar, I.C.S., and forms a sequel to a similar review "The State and Industries" by Mr. A. G. Clow for the years 1920–1928.

Technical and Industrial Education.—The stress of unemployment among the middle classes has brought home to parents and sons alike the increasingly small value from the pecuniary point of view of the purely literary type of education imparted in schools and colleges and the imperative necessity of seeking new fields of employment in the industrial world. The gradual development of industry has steadily widened the effective demand for the services of those who have received industrial training and has thus stimulated the expansion of schools and colleges to meet the need. A large number of technical and industrial schools have come into being throughout India and numerous scholarships have been instituted to encourage students.

Cottage Industries.—The Handloom industry is not confined to the class of hereditary weavers. It provides a subsidiary occupation to the agriculturist at the season when work on the field is slack. In order to develop this industry, the Government of India decided to spend to the extent of 5 lakhs of rupees every year for a period of 5 years, and schemes were formulated and discussed. These schemes provide for improvements in marketing, appointment of technical experts and supply of materials at cheap rates. Similar action was taken by the Government with a view to assist the silk industry, and an annual grant of Rupees one lakh for five years—1935-40—was made. An Imperial Sericultural Committee was set up, which met in 1935 to scrutinise schemes submitted by local governments. More recently, the Government has taken an important step to aid the cottage and small scale woollen industries by making a special grant of Rupees five lakhs spread over five years and a Special Woollen Industry Committee has been set up to advise the Government of India on the question of allotments. The crux of the problem of developing cottage industries is to find a suitable market for the products. Accordingly, the question of efficient marketing organisati-

handloom products was thoroughly studied and promising schemes based on co-operative effort have been adopted. An important feature of the development of cottage industries is the exhibitions organised by Government departments. Besides these, numerous publications have been ushered in, to disseminate commercial intelligence and useful surveys of different industries are being undertaken.

The Governments of Madras, the Punjab and the United Provinces have made several successful efforts to develop the hydro-electric resources of the country, thus making provision for cheap power for industrial consumers.

One of the most outstanding events of the period under review has been the establishment of the Industrial Research Bureau, by the Government of India, which has already undertaken a heavy programme of work and is contributing valuable observations on industrial methods.

The record also deals with the fiscal measures adopted by the Government for assisting industries. Among articles receiving protection are paper, salt, matches, wheat, silver thread and wire, silver plates and like manufactures, magnesium chloride, etc. The policy regarding iron and steel, cotton and other textiles, and sugar is also dealt with. The Government is further affording all possible encouragement to the development of industries in India by giving a definite preference in making purchases for articles of indigenous manufacture.

An exhibition of Indian manufactured articles has been organised in the Imperial Secretariat Buildings, New Delhi, for bringing prominently to the notice of indenting authorities and the general public the standard of quality attained in certain industries.

* * *

Nature reports that **Dr. John Henry Hutton** well known in India as the author of the monumental *Census Report* of 1931, has been appointed a Lecturer in the Faculty of Archæology and Anthropology in the University of Cambridge for a period of three years as from October 1st. Dr. Hutton entered the Indian Civil Service in 1909 and during the 27 years of his service he had ample opportunities to come into contact with the peoples of India. He made a special study of the ethnography of the Nagas of Assam, the results of which study have been incorporated in two monographs published under the auspices of the Government of Assam. His *Census Report* published in 1933, is a remarkable document which has ensured for him a prominent place among the scientists as an expounder of the racial history of India. He was General President of the Indian Science Congress, 1935, and President of the recently formed Indian Anthropological Institute.

* * *

Malaria and Nutrition.—*Nature* announces that at a meeting of the Council of the Royal Society held in July, it was decided that the whole income together with the invested income of its Medical Research Funds should be employed for a period of 5 years on a scheme of laboratory research on Malaria to be conducted in England, and a field enquiry into malnutrition in India. Lieut.-Col. J. A. Sinton, lately Director of the Malaria Survey of India, has been appointed to conduct the first part of the malaria programme. He will work in the laboratories of the Malaria Therapy Centre at Horton.

Dr. Curgel Wilson has been appointed to conduct the Malnutrition Survey of India in collaboration with Dr. Aykroyd, Director of the Nutritional Research Institute, Coonoor. The problem of malnutrition in India is one of the major problems (see *Current Science*, 1935, **4**, 75) requiring immediate attention and it is hoped that the survey which will be concerned chiefly with the incidence of malnutrition among school children and the dietary habits of groups of families in the districts where the children live, will be to the lasting benefit of India.

* * *

Dr. H. S. Rao of the Zoological Survey of India received a specimen of *Hippocampus kuda* Bleeker, 6 inches long from the vicinity of Port Bonnington, North Andamans, where it was collected by Mr. M. Balasubramanian of the Forest Department on the 2nd July 1936. The fish was caught on the southern shore of the Steward Sound not far from Mangrove Island in a fishing net along with sardines in about 3 feet of water over a sandy bed. According to the information supplied by the collector the local Andamanese know this fish casually and only from deep water, while the Burmese settlers believe that paste made with this fish is an antidote for snake and centipede venom.

This sea-horse is a littoral species widely distributed along the tropical coasts of the Indian and Pacific Oceans as far east as the Hawaiian Islands north of Japan. The observation that a paste prepared from the "Godha machi" (*Hippocampus*) is an effective cure for snake or centipede bite is new and well worth recording.

* * *

Nitrogen Transformations in the Soil.—Addressing the *Society of Biological Chemists*, at Bangalore, on "Nitrogen Transformations in the Soil," Prof. N. R. Dhar of Allahabad stressed the importance of molasses as an effective means of increasing the nitrogen content of Indian soils, which as a class are poor in this essential constituent when compared to soils of temperate and cold climates. The excessive heat and moisture of the tropics which account for the rapid depletion of soil organic matter and loss of nitrogen, could be utilised to help nitrogen fixation and augment the nitrogen reserves of the soil through the application of molasses. In the rapid photochemical and bacterial oxidation of molasses, large amounts of energy are set free, which result in the production of ammonia and nitrates. Application of molasses 2 or 3 months before sowing and subsequently ploughing 3 or 4 times, has been found to give greatly increased yields from rice, sugarcane, etc. Another important observation of Dr. Dhar is the great utility of molasses in the reclamation of alkaline soils. In this respect, molasses appears to be more effective than gypsum or powdered sulphur and requires a much shorter time to show results. Alkaline lands have been successfully reclaimed in different parts of the United Provinces and of Mysore by the application of molasses and crop yields obtained where no vegetation grew before.

* * *

Manufacture of Liquid Chlorine in India.—Under the auspices of the Technological Association, University of Bombay, Mr. G. S. Gulrajaney read a paper on 'The Possibility of Liquid Chlorine Manufacture in India,' on the 28th September. The present demand for liquid chlorine

is estimated at 360 tons per annum, valued at 2½ lakhs of rupees. The principle use of liquid chlorine is for bleaching bamboo pulp. About half the quantity is used up in Bombay and there is ample scope for installing a plant, with a daily output of 1,000 to 1,500 lb. of liquid chlorine. The capital requirements for such a concern is estimated at 20 lakhs of rupees and it is expected that it will be able to pay a dividend of about 10 per cent. The product can be marketed at 3 as. per lb., as against 5 as. per lb. at which the imported article is sold.

* * *

The Problem of Trisection of Any Angle.—(By Sri Niwas Asthana).—By using an elaborate set of constructions, the author believes that he has successfully solved a classical problem. His proof, published about two years ago, in the form of a pamphlet was not accepted, and he has now made an attempt to correct the mistake in his proof. Unfortunately, a mistake occurs in the very same place, only under different wordings.

The problem is closely allied to the problem of solving a cubic equation by means of quadratic Surds only, and it is known that the problem is insoluble "if in our constructions we restrict ourselves to the use of circles and straight lines, that is, to Euclidean Geometry" (W. W. R. Ball, *Short History of Mathematics*, p. 37; also refer to J. W. A. Young, *Monographs on Modern Mathematics*, p. 364).

Mr. Sri Niwas Asthana is a schoolmaster gifted with remarkable enthusiasm and "geometrical patience," and would surely be able to do interesting work if he attempts other problems instead of worrying himself about an insoluble problem. C. N. S.

* * *

An important event connected with the recent meeting of the British Association at Blackpool is the amalgamation of the British Science Guild with the Association.

* * *

The foundation of the British Science Guild in 1905 was primarily due to the efforts of Sir Norman Lockyer, the celebrated founder of *Nature*. Lord Haldane was its First President. The Guild's aim is to influence public opinion and to promote closer contact between science on the one hand and social problems and public affairs on the other. Since the Association has also pursued the same aim in recent years it was considered desirable to incorporate the Guild with the British Association.

* * *

The Geological, Mining and Metallurgical Society of India.—The Twelfth Annual Meeting of this all-India body was held at Calcutta, the Society's headquarters, on 24th August. Prof. N. P. Gandhi, the President, delivered an address on India's drift without a mineral policy.

During the year 1935–36, the Society held 8 ordinary meetings for reading and discussing scientific communications, and 9 Council meetings for transacting ordinary business. Among the important steps taken by the Council, mention may be made of the addition of a Review Section to the *Quarterly Journal* of the Society. The Society has kept up its usual level of activity, and its Journal has maintained a high standard. As many as 16 papers were published in the Journal mostly pertaining to Geology. It is hoped that papers dealing with Mining and Metallurgy will find place in the *Quarterly Journal*, the official expositor of the activities of the Society.

* * *

The National Academy of Sciences, India.—At the Ordinary Monthly Meeting of the Academy held on 15th September 1936 the President announced that the Imperial Council of Agricultural Research has made an annual grant of Rs. 500 for a period of three years to the National Academy of Sciences, India, to meet the publication expenses of the Academy.

At the same meeting, Mr. B. K. Bhatnagar, B.Sc. (Allahabad) and Mr. Hrishikesha Trivedi, M.Sc. (Lucknow) were elected Members.

* * *

Calcutta Mathematical Society.—At the meeting of the Society held on the 5th, Mr. H. N. Gangully, M.A. (Patna) and Mr. N. Chatterjee, M.A. (Bankipur) were proposed for election as ordinary members.

* * *

Sir Edward Poulton, Emeritus Professor of Zoology at Oxford, the well-known entomologist and Darwinian, has been elected President by the British Association for the Advancement of Science for 1937. The meeting will be held at Nottingham from September 1 to 8.

* * *

News has been received that DR. B. S. GUHA of the Indian Museum, Calcutta, has been elected a member of the Comite International de Preparation Scientifique of the Institut International D'Anthropologie. He has also been recently elected a member of the Comite Permanent de Recherches pour la Standardisation des methodes anthropologiques of the Congress International Des Sciences anthropologiques and is on the Executive Body of the section dealing with anthropometry.

* * *

Dr. Habib Abdur Hafiz is confirmed as Assistant Superintendent of the Zoological Survey of India.

* * *

Dr. S. S. Bhatnagar has returned to India after his European tour, in which he represented the University of the Punjab at the Empire Universities Conference.

* * *

In the death of **Monsieur Paul Kestner** (*b.* 1864) the scientific world is deprived of an eminent chemical engineer and industrial chemist, gifted with great inventive ability. He was the Founder of the firm of Paul Kestner at Lille, the name of which was subsequently changed to Société Anonyme Appareils et Evaporateurs Kestner. His inventions cover a very wide field; mention may be made of the improvement of lead chambers in sulphuric acid manufacture, fans to deal with corrosive acid fumes, and the well-known Kestner Evaporators. After the Great War, Paul Kestner occupied himself with researches in agriculture and vegetable physiology.

* * *

Announcements:

The King George Thanksgiving (Anti-Tuberculosis) Fund Committee has decided to hold the next post-graduate course for training in tuberculosis at the All-India Institute of Hygiene and Public Health, Calcutta, from the 4th to the 30th January, 1937. The number of students will be limited to 25 as a greater number cannot be dealt with effectively for demonstration and clinical purposes. Selected candidates will be

paid by the Thanksgiving Fund second class return railway fares from their stations to Calcutta and back subject to a maximum of Rs. 100, the balance being met by the candidates themselves or their employers.

Medical men, whether private practitioners or in the service of a government, railway, municipality, etc., are eligible to apply. Applications should be submitted by the 1st November 1936, in the prescribed form, which can be obtained from the Organising Secretary, King George Thanksgiving (Anti-Tuberculosis) Fund, from 20, Talkatora Road, New Delhi.

Applications should reach Dr. A. R. Mehta, the Organising Secretary of the Thanksgiving Fund, by the 1st November 1936. Those received after this date will not be entertained.

* * *

Imperial Council of Agricultural Research.—Applications are invited for the award of prizes, *during* 1937, for improvements in *Machinery for Preparing Crops for Market, for Food or for Storage.*

On the 7th June 1933, it was announced that the Imperial Council of Agricultural Research would award annually one Gold and two or three Silver Medals for improvements of distinct merit in the science and art of agriculture and animal husbandry of an all-India importance and that awards would be made each year in one of the five groups, *viz.*, (1) Veterinary Scientific Instruments and Appliances (1934). (2) Dairying and care of animals (1935). (3) Field Implements and Appliances (1936). (4) Machinery for Preparing Crops for Market, for Food or for Storage (1937). (5) Water Lifts (1938).

Entries will be submitted in the first instance to the Provincial Agricultural Research Committees which will forward to the Council those which they consider suitable with a description of entries that have been rejected.

All entries for the award should reach the Secretary, Imperial Council of Agricultural Research, through the proper channel not later than 1st December 1936. Entry forms and the conditions to be fulfilled can be obtained from the Secretary, Imperial Council of Agricultural Research, Simla.

* * *

We acknowledge with thanks receipt of the following :—

"The Agricultural Gazette of New South Wales," Vol. XLVII, No. 9, Sept. 1936.

"Journal of Agricultural Research," Vol. 53, No. 1, July 1936.

"Indian Journal of Agricultural Science," Vol. VI, No. 4, Aug. 1936.

"Monthly Bulletin of Agricultural Science and Practice," Vol. 27, No. 8, August 1936.

Dominion of Canada, Department of Agriculture : National Research Council—

"The Comparative Feeding Values for Poultry of Barley, Oats, Wheat, Rye and Corn."

"The Philippine Agriculturist," Vol. XXV, No. 4, September 1936 and Index for first 20 volumes.

"The Allahabad Farmer," Vol. X, No. 5, August 1936.

"Journal of the Royal Society of Arts," Vol. LXXXIV, Nos. 4370–4374.

"Biochemical Journal," Vol. 30, No. 8, Aug. 1936.

"Chemical Age," Vol. 35, Nos. 895–899.

"Journal of Chemical Physics," Vol. 4, No. 9, September 1936.

"Journal of the Indian Chemical Society," Vol. 13, No. 8, August 1936.

"Berichte der Deutschen Chemischen Gesellschaft," Vol. 69, No. 9.

"Journal de Chemie Physique," Vol. 33, Nos. 8–9, August–September 1936.

"Experiment Station Record," Vol. 75, No. 2, August 1936, and Index to Vol. 73.

"Transactions of the Faraday Society," Vol. XXXII, Pt. 9, September 1936.

"Indian Forester," Vol. LXII, No. 10, Oct. 1936.

"Forschungen und Fortschritte," Vol. 12, Nos. 26–27.

Government of India Publications :—

"Monthly Statistics of Production of Certain Selected Industries of India" (Department of Commercial Intelligence and Statistics), No. 3, June 1936.

"Annual Report of the Imperial Council of Agricultural Research for 1935–36."

Indian Meteorological Department, Scientific Notes, Vol. XXIV, Part VI : "Typhoons and Indian Weather."

"Indian Trade Journal," Vol. CXXII, Nos. 1577–1580.

Report of the Haffkine Institute, Bombay, for 1932-35.

Annual Report of the All-India Institute of Hygiene and Public Health, Calcutta, 1935.

University of Illinois Publications, Vol. 33, No. 42—"A Study of the Reactions of Various Inorganic and Organic Salts in Preventing Scale in Steam Boilers."

League of Nations Publications—"The Problem of Nutrition, Vol. IV—Statistics of Food Production, Consumption and Prices."

"Marriage Hygiene," Vol. III, No. 1, Aug. 1936.

"Journal of the Indian Mathematical Society," Vol. II, No. 3, 1936.

"The Calcutta Medical Journal," Vol. 31, No. 3, September 1936.

"Medico-Surgical Suggestions," Vol. 5, No. 8, August 1936.

"Electrotechnics," No. 9, April 1936.

"Review of Applied Mycology," Vol. 15, No. 8, August 1936.

International Institute of Agriculture—"Bibliography of Tropical Agriculture, 1935."

"Journal of the American Museum of Natural History," Vol. 38, No. 2, September 1936.

"Journal of the Bombay Natural History Society," Vol. 38, No. 4.

"Nature," Vol. 138, Nos. 3486–3490.

"Journal of Nutrition," Vol. 12, Nos. 2–3.

"Indian Physico-Mathematical Journal," Vol. 7, No. 2, September 1936.

"Canadian Journal of Research," Vol. 14, No. 8.

"Journal of Research, National Bureau of Standards," Vol. 16, No. 2.

"Scientific American," Vol. 155, No. 4, Oct. 1936.

Catalogues:

"Monthly List of Books on Natural History and Science," September 1936 (Messrs. Wheldon & Wesley, London).

"Mitteilungen über Neuerscheinungen und Fortsetzungen," 1936, No. 4, September (Messrs. Verlag von Gustav Fischer in Jena).

"Bell's Miscellany, Autumn Books," 1936 (Messrs. G. Bell & Sons, Ltd.).

"Cambridge Autumn Books, 1936" (The Cambridge University Press).

"Balopticons and Accessories" (Messrs. Bausch & Lomb, Rochester, N. Y.).

ACADEMIES AND SOCIETIES.

Indian Academy of Sciences.

September 1936. SECTION A.—I. Z. SAIYED AND D. D. KANGA: *Chemical Examination of the Fruits of* Solanum xanthocarpum. S. CHOWLA: *Pillai's Exact Formulæ for the Number* g(n) *in Waring's Problem.* N. S. NAGENDRA NATH: *The Visibility of Ultrasonic Waves and Its Periodic Variations.*—A general theory has been developed and it is shown that the periodic visibility is characteristic of any general periodic supersonic wave. R. D. GUPTE: *Distribution of Temperature and Vapour Pressure in the Neighbourhood of a Water-Surface.*—With wind speeds varying from 0 to $2\frac{1}{2}$ metres per second, when the water-surface was warmer than air, there were conspicuous fluctuations of temperature above the water-surface, the maximum fluctuations being at a height of about 1 cm. from the surface. S. SIDDIQUI, R. H. SIDDIQUI AND S. K. SHARMA: *Studies in the Conessine Series. Part II.—Relationship between N-Stability and Pharmocological Action of Conessine and Iso-Conessine.* T. S. WHEELER: *On the Theory of Liquids. Part VI.—The Rate of Reaction in Liquids. Part VII.—Diffusion and Vapour Pressure Phenomena.* S. NIYOGY: *Organo-Metalloid Compounds. Parts I and II.*—Stibinic acids corresponding to the trypanocidal arsenic compound "Albert 102," have been prepared and their physiological action examined. V. GANAPATHY IYER: *On the Maximum Modulus Curves of Holomorphic Functions.* CH. V. JOGARAO: *An Optical Investigation of Some Indian Oils. I.—Depolarisation of the Scattered Light.*—The oils studied showed a depolarisation factor of 100% with incident light horizontally polarised, thus behaving as normal liquids. SATYA PRAKASH: *On Non-Spherical Nature of Colloidal Particles in Relation to the Formation of Jelly Structure.*—It is shown that many of the well-known jelly forming sols do not exhibit magnetic birefringence. The case of mercuri-sulphosalicylic acid sol has been studied in detail. C. S. VENKATESWARAN: *The Raman Spectra of Sulphur and Phosphorus. Part I.—Polarisation and Molecular Structure.*—From the polarisation studies, it is concluded that the P_4 molecule is tetrahedral while the S_8 molecule is considered to be a symmetrical puckered ring made up of two squares of four atoms each, one square placed at 45° with respect to another. B. S. MADHAVA RAO: *Ring-Singularity in Born's Unitary Theory—I.*—An elementary particle is considered as a ring-singularity. B. S. MADHAVA RAO: *A Theorem on Action Functions in Born's Field Theory.*

September 1936. SECTION B.—H. R. BHARGAVA: *The Life-History of* Chenopodium album *Linn.*—A fairly detailed description of the life-history of one member of the family of the Chenopodiaceæ has been provided. R. P. ASTHANA: *Antagonism in Fungi as a Measure of Control in 'Red-Leg' Disease of Lettuce.*—The parasitic vigour of *Botrytis cinerea* can be suppressed by a number of fungi of which *Trichoderma lignorum* and *Phoma* sp. are particularly effective. The filtrates of the medium in which these fungi thrive, produce the same effect, thus suggesting that the action is due to staling products. L. RAMA RAO: *The Deccan Traps.*—A brief review of the present knowledge of the Deccan Traps has been furnished and a new interpretation of the mode of their accumulation and biological history given. B. S. KADAM: *Genic Analysis of Rice. I. Grain Shedding.*—Studies on the crossing of a wild rice which sheds its grain completely with a Burmese variety, *Paungbalaung* 3, which is a non-shedder, show that this character is completely dominant and is caused by the duplicate genes Sh_1 and Sh_2. BENI CHARAN MAHENDRA: *On Two Collections of the Ophidian Genus,* Cylindrophis *Wagler.*—The distinctive features generally recognised between the three species of *Cylindrophis* Wagler do not stand the test of a thorough and intensive scrutiny of a representative collection. A new key for this genus is furnished. M. S. RANDHAWA: *Three New Species of* Zygnema *from Northern India.*—The reproductive phase of the three remarkable species of genus *Zygnema* studied shows many peculiarities. M. S. RANDHWA: *A Note on Some Attached Forms of* Spirogyra *from the Punjab.* BENI CHARAN MAHENDRA: *Contributions to the Bionomics, Anatomy, Reproduction and Development of the Indian House-Gecko,* Hemidactylus flaviviridis *Rüppel. Part I.*

The National Academy of Sciences, India:

September 15, 1936.—BINAYENDRA NATH SEN: *On the Direct Formation of Iodides and the Distance of the Closest Approach of Atoms of Iodine.* R. K. SHASTRY: *Theorems Connecting Different Classes of Self-Reciprocal Functions.* RAM BEHARI: *Curved Asymptotic Lines of Ruled Surfaces.*

Indian Mathematical Society:

RAM BEHARI: *Generalisations of the Theorems of Malus-Dupin, Beltrami and Ribaucour in Rectilinear Congruences.*—The generalisations refer to the *pitch of the pencil* at any ray of the congruence,—a concept which has been defined and discussed in a previous paper by the author, published in *Journ. Ind. Math. Soc.*, Vol. I, No. 4. DURGA PRASAD BANERJEE: *A Note on the Zeros of Parabolic Cylinder Functions of the Second Kind.*

$$\text{Let } E_n(x) = \pm\, e^{\mp n\pi i}\; i\sqrt{2\pi}\;\Gamma(n+1)\times D_{-n-1}(\mp ix)\, e^{-\frac{1}{4}x^2},$$

where the upper or the lower sign is to be taken according as $I(x) > 0$ or $I(x) < 0$, and where $D_n(z)$ is the familiar cylinder function. When x is not real and n is a positive integer, $E_n(x)$ has been shown by Dr. Watson to be equal to

$$\int_{-\infty}^{+\infty} \frac{e^{-\frac{1}{4}z^2} D_n(z)}{z-x}\, dz$$

Mr. Banerjee proves in this paper the following theorem:—

The functions $E_n(x)$ and $E_{n+m}(x)$ have no common zeros, $n+1$ being not a negative integer, and m being a positive integer. V. GANAPATHI IYER: *On Integral Functions of Finite Order Bounded at a Sequence of Points.*—Another

paper extending the results of the previous paper in *Journ. Ind. Math. Soc.*, Vol. II, No. 1. (MISS) S. PANKAJAM: *On Euler's ϕ-Function and Its Extensions.*—The author uses a logical argument developed by Dr. R. Vaidyanathaswamy in his paper in *Proc. Ind. Acad. Sci.*, Vol. II, No. 1, to obtain the values of the familiar $\Phi(n)$ in the theory of prime numbers, and to the generalisaions of this function by Jordan, Schemmel and Lucas. She also works out a further generalisation which will include Jordan's function as a special case. If $J_{rs}(n)$ denotes the number of sets of r integers ($\leqslant n$) whose sth greatest common divisor (a concept introduced by R. Vaidyanathaswamy in his paper *loc. cit.*) is prime to n, then the author establishes that

$$J_{rs}(n) = n^r \left[1 - f_{rs}\left(\frac{1}{p_1}\right)\right] \left[1 - f_{rs}\left(\frac{1}{p_2}\right)\right] \cdots \left[1 - f_{rs}\left(\frac{1}{p_q}\right)\right]$$

where

$$f_{rs}(x) = x^r + \binom{r}{1} x^{r-1}(1-x) + \cdots + \binom{r}{s-1} x^{r-s+1}(1-x)^{s-1}.$$

Society of Biological Chemists, India:

September 1936.—T. R. BHASKARAN: *The Mechanism of Biological Nitrogen Fixation.* (MISS) K. BHAGVAT: *The Digestibility of Caseins in Their Natural and Artificial Environments.* DEWAN BAHADUR SIR T. VIJAYARAGHAVACHARYA: *Agriculture and Population.* A. VENKATASUBBAN: *Some Colloid Chemical Aspects of Paint Manufacture.* M. SREENIVASAYA: *The Present Status of the Spike Problem of Sandal.* DR. N. R. DHAR: *Nitrogen Transformations in the Soil.*

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

University of Calcutta:

The Calcutta University has taken on hand the proposal for introducing a degree in architecture. A Committee of the Board of Studies in Engineering has been appointed for drawing up the rules and regulations for the institution of such a degree as also the courses of studies for the same, as an extension of the Intermediate course of studies in Engineering.

Major A. C. Chatterjee, I.M.S., has been invited to deliver a course of lectures as *Basanta Lecturer* of the University for the year 1936 on "The Problem of Malaria in Bengal".

Essays for the award of Basanta Medal for 1936 should be submitted before the 30th April 1937. The subject selected is "Bengali Diet—Its Effects on Health".

Osmania University:

Five Research Scholarships each of Rs. 75 per mensem, tenable for two years have been awarded by the University for Post-M.A. and M.Sc. work this year. Dr. M. Qureshi, Head of the Department of Chemistry, has been appointed Secretary, Board of Research.

Dr. Raziuddin Siddiqi, Professor of Mathematics, at present on study leave in England, has been deputed to attend the London University celebrations as representative of the Osmania University.

Two special evening classes for the teaching of Arabic and Sanskrit have been started this year, for the benefit of the students, members of the staff and the public from outside. Dr. Hamidullah, M.A., LL.B., Ph.D., is conducting the Arabic class while Pandit Harihar Shastri takes the Sanskrit class. Separate classes for the teaching of German and French have been in existence for a number of years in the University.

A Music Association with Professor M. Saiduddin, Head of the Botany Department, as president has been formed with the object of encouraging the cultivation of music among the students of the University.

The Pro-Vice-Chancellor has appointed a Board with Dr. Mir Valiuddin of the Philosophy Department as Secretary, for giving advice to the students seeking to appear for competitive examinations for Hyderabad and All-India Public Services.

The University has suffered an irreparable loss in the death of A. H. Mackenzie, Esq., M.A. D.Litt., C.S.I., C.I.E., its Pro-Vice-Chancellor, which occurred in Scotland on Saturday, the 26th September 1936, after an illness of about six months. When the news of the sad death was received in Hyderabad on Monday the 28th September all the institutions of the University were closed and the staff and the students assembled at a condolence meeting where a resolution expressing feelings of sorrow and sympathy with the bereaved family was passed.

University of Mysore:

Extension Lectures.—Dewan Bahadur Sir T. Vijayaraghavacharya, K.B.E., delivered a lecture on "The League of Nations—Its Future" at Bangalore and at Mysore.

Faculties.—The following have been elected Deans of the reconstituted faculties:—

Faculty of Arts: Mr. V. L. D'Souza; Faculty of Science: Mr. K. S. K. Iyengar; Faculty of Medicine: Mr. S. Subba Rao.

Central Advisory Board of Education:

Mr. V. N. Chandavarkar, Vice-Chancellor of the Bombay University, has been elected member of the Central Advisory Board of Education by the Inter-University Board in the place of Sir S. Radhakrishnan, resigned.

1464-36.—Printed at The Bangalore Press, Bangalore City, by G. Srinivasa Rao, Superintendent, and Published by B. N. Sastri, M.Sc., A.I.C., A.I.I.Sc., for the "Current Science" Board of Editors, Indian Institute of Science, Hebbal Post, Bangalore.

CURRENT SCIENCE

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British Association and British Science Guild.

VARIED reflections arise from a recent announcement that the British Science Guild will be absorbed by the British Association for the Advancement of Science. At its foundation in 1831, Sir David Brewster stated that the principal purposes of the Association would be "to make the cultivators of science acquainted with each other, to stimulate one another to new exertions, to bring the objects of science more before the public eye, and to take measures for advancing its interests and accelerating its progress."

These words, written more than a century ago, remain to-day the specification of activities ranged by the Association. Probably the most useful of them is " to bring the objects of science more before the public eye," and the September meeting in Blackpool accomplished this purpose very conspicuously. From readers of *The Times*, regaled with a pontific leader on the presidential address by Sir Josiah Stamp supported by columns of extracts from the sectional addresses, down to the Blackpool chambermaid whose principal reaction to the learned and unusual visitors lay in perceiving an increased number of "beards and boots," few Britons can have escaped its impact. There was a time, however, when the Association, as judged by some of its leading members, made insufficient contact with the public; and attention to this imperfection was drawn by Sir Norman Lockyer in his presidential address at Southport (1903) entitled "Influence of Brain Power on History."

Thus came into being the British Science Guild, whose declared object was "to promote the application of scientific method and results to social problems and public affairs." By means of annual addresses named after the founder Sir Norman Lockyer, and Sir Alexander Pedler, coupled with allied activities, the Guild has fully achieved its object within the limits of its resources. Latterly, however, particularly from 1931 when the presidential chair was illustriously occupied by General the Rt. Hon. J. C. Smuts, the British Association itself has given increasing

prominence to social science; and this year's programme included in a separate division the titles of numerous addresses, discussions and papers bearing on the relation between science and the community. In future too, at least one discussion and one evening discourse will cover the application of science to social problems.

Doubtless the British Science Guild, by helpful symbiosis, has been in part responsible for this regeneration of the older body. More potent, however, has been a queer superstition among ascientific publicists that our present mundane woes are somehow owing to the phenomenal advance of science and that men of science being the cause of our troubles, it is their business to adjust them. Twisted as this hypothesis may appear to many, it should not preclude men of science, presumed to be no worse and no better than other citizens, from doing their best in alleviating the present sorrows of citizenship; and if science justifies its definition as organised common sense, a happy issue should emerge. Meanwhile, the Guild may be bidden a grateful farewell, with the comforting assurance that its work has been well and truly done, and that its origin will be conserved in the British Science Guild Committee of the British Association Council. Its action in undergoing voluntary absorption is a seemly example of the now fashionable rationalisation process.

The Discovery of Hafnium.

By G. Hevesy.

(Institute of Theoretical Physics, University of Copenhagen.)

Introduction.

THE discovery of about four-fifths of the chemical elements without any guidance from the theoretical side and without the aid of the powerful tool provided by spectroscopy, is an outstanding and everlasting monument of the skill, industry, and genius of the experimental chemist. It is with great admiration and deep reverence that we read the papers of the pioneers who succeeded with the primitive tools and methods of their time in discovering and isolating the large majority of the elements. The work of the discoverers of the elements was immensely facilitated later by the introduction of the spectrograph into chemical analysis and by the generalisation put forward by Mendejeleff. It was the guidance offered by the latter which led to the discovery of scandium, gallium, germanium, and recently of rhenium. The periodic classification, so far-reaching in its basic conception and in its applications, failed nevertheless to explain the existence and to limit the realm of the groups of triads and of the large family of rare earth elements. From Moseley's work we could conclude that no more triads are to be expected and that the rare earth group (incl. lanthanum) is limited to a maximum of 16 elements. But the significance of the groups of triads and of the rare earth group was still unexplained and the exact size of the latter still unknown. An explanation was hardly to be expected without a deeper insight into the nature of the periodic classification. Niels Bohr gained such an insight in the course of his classical studies on the building up of the atoms of the chemical elements from nuclei and electrons.

One of the most important points in Bohr's electronic arrangement is that on passing from one element to the next one the number of electrons increases by one, the new electron usually being added to an outermost electronic shell. As the chemical behaviour of the atom depends chiefly on the outermost shell, neighbouring elements in the periodic table will, in most cases, be chemically very different; but in some cases the electronic arrangements might differ in such a way as to give successive elements similar properties. The newly added electron tries to find as stable a configuration as possible and it may happen that an innershell successfully competes with the outermost one in capturing the electron. Such an event is first encountered in the case of scandium, but the most conspicuous one is that of cerium. In the latter case the preference for the new electron is not given to the outermost P shell, nor even to the next one O, but is given to the inner shell N. After cerium come a number of elements all characterised by the binding of the newly coming electron in the deep N shell and it is clear that in this group of elements, all having the same configuration in their outermost shell and differing only in an

inner one, the individual members will not differ very distinctly in chemical properties.

In the light of these considerations the existence of the so-called "rare earth" group is no longer an unexplained anomaly of the periodic system but a natural consequence of its development. As the N group has 32 electrons and 18 were already present in xenon and the preceding elements, the number of rare earth elements cannot exceed 14 including cerium. Cerium being of atomic number 58, the last rare earth element must have an atomic number 71; element 72 must belong to the titanium and 73 to the vanadium group. In conflict with this conclusion, the literature records the existence of 15 rare earth elements, including cerium and the missing element 61. These 15 elements include also number 72 which, however, according to Bohr's theory, should belong to the titanium group. Besides giving a deep insight into the nature of the periodic classification of the element Bohr's considerations thus supplied an effective guidance in searching for element 72 in the same sort of way that Mendejeleff's generalisation guided the discoverer of scandium, gallium, germanium, and rhenium. I have been asked by the Editor of *Current Science* to describe the discovery of hafnium and it is with great pleasure that I write the contribution requested by this high-standing periodical.

DISCOVERY OF HAFNIUM.

Bohr's theory of the arrangement of the electrons in the different chemical elements was the impetus for the search for a missing member of the titanium group in exactly the same way as Mendejeleff's generalisation induced the search for other missing members of the periodic system. It is of interest to note that in Bohr's famous paper, so far-reaching in its interpretation of the phenomena of optical and X-ray spectroscopy, magnetism, and chemistry, the suggestion that, contrary to the claim of Urbain and his followers, element 72 is not a trivalent element of the rare earth group but a tetravalent of the titanium group, has had to content itself with a modest footnote. It is not too much to say that only in a very few cases has the following up of the suggestions given in the footnotes of scientific publications led to such striking results as in the present instance. But the impetus given, however important, was far from being sufficient and the discovery of the element 72 was due to the happy coincidence of several different events. Six months after the publication of Bohr's famous paper the present writer embarked on the study of geochemical papers including the first publication of Goldschmidt on the distribution of the chemical elements, a paper which was later followed by a long series of most illuminating and unrivalled papers by the famous Norwegian scientist. The study of geochemistry led my interest to the problem of missing elements including element 72. It seemed, however, very doubtful whether the concentration of the element in question would be sufficient to detect it; nor was it clear at the time whether element 72 should be looked for in thorium or in zirconium minerals. I decided to search for the element when a suitable opportunity presented itself. It happened that Coster, who was even then an authority on X-ray spectroscopy, joined the Bohr institute. We made plans for a joint investigation of the effect of very intense and hard X-ray radiation on the rate of radioactive disintegration of radio-lead, by measuring the β-activity of a radio-lead plate before and after irridation with X-rays. While we were waiting for the necessary equipment, I suggested to Dr. Coster that we might look for element 72. We did not know at the time whether this element would be found associated with thorium or with zirconium but considered the latter the more probable. Professor Böggild, Director of the Mineralogical Museum of Copenhagen, kindly supplied me with samples of Norwegian and of Greenland Zircon, and after treating them with boiling acids to remove the soluble constituents, the pulverised sample was fixed on to a copper anticathode. The first exposure taken by Dr. Coster, revealed at once the presence of the element looked for. We then tried to identify the hafnium α_1 line in other zirconium-minerals and also in commercial zirconium preparations, and were successful in every case. The next step was to try to identify other X-ray lines, α_2, β, γ, and so on, and finally to endeavour to change the intensity of the α_1 line by chemical treatment of the mineral. I was much impressed in those days by Marignac's beautiful researches on zirconium double fluorides and this led us to extract potassium-zirconium-fluorides from zircon and to crystallise that compound repeatedly. As the solubility of K_2ZrF_6 is fairly pronounced, while that of the thorium salt is

very slight, we expected the corresponding compound of element 72 to concentrate in the crystals. The hafnium line obtained from the crystals was, however, much weaker than the line given by the original minerals whereas the mother liquor showed a very marked increase in its hafnium content. It was after we had successfully separated hafnium from zirconium by chemical means that Coster and the present writer announced the discovery of the new element, proposing for it the Latin name of Copenhagen, *Hafnium*.

Our next aim was to elucidate the optical spectrum of the new element. We hoped to obtain both the arc and the spark spectrum from the mother liquor of a double fluoride crystallisation of the mineral in which hafnium was first found. Hansen and Werner, who photographed the spectrum found, however, only a very intense niobium spectrum free of tantalum lines. This result, which discouraged them at first, was due to the fact that the double fluoride of the oxyniobate is a very soluble compound, much more soluble than the soluble fluoride of tantalum, zirconium, or even hafnium, so that niobium concentrated in the most soluble fraction. The present writer did not share that discouragement but thought the next best fraction must contain a hafnium concentrate, and this was found to be actually the case. The elaborate work of Meggers identified several thousand lines of the hafnium spectrum, and he showed too that 26 of these lines are to be found among those ascribed by Exner and Haschek to zirconium. On the other hand in the arc spectrum of zirconium measured by Rowland only one hafnium line occurs. By noticing this discrepancy in the zirconium spectrum given by Exner and Haschek and by Rowland it should have been possible to have discovered hafnium many years ago. Accurate atomic weight determinations carried out on zirconium of different origin might also have led to the discovery of the element, but the methods used in early days, which were based on the analysis of the sulphate, selenide, or oxychloride were not trustworthy and yielded mostly values too low, the error being, however, to a large extent compensated by the presence of an appreciable amount of hafnium in the preparations investigated. Venable and Bell, on the other hand, who were the first to use the modern methods of determining the atomic weight of zirconium, namely, the analysis of the tetrachloride, found in spite of very careful work, too high a value, due, as the present writer was able to ascertain, to the presence of 0·7 to 1·0 per cent. hafnium oxide in the zirconium used. While an early discovery of element 72 might have been achieved by comparing the optical spectrum, the atomic weight, or the density of zircon extracted from different minerals, one can hardly imagine that this element could have been discovered by following up the chemical reactions of zirconium compounds of different origin. The chemical similarity between the compounds of zirconium and hafnium is as close as, or closer than, that between any other pair of elements in the Periodic Table. We were very fortunate when we embarked on the separation of hafnium from zirconium to hit straight away on just the two compounds which are most suitable for making the separation desired. These are the phosphates and the potassium (or ammonium) hexafluorides. The hafnium compounds prepared on a semi-commercial scale by the "Auer-Gesellschaft" in Berlin are obtained by crystallisation of the fluorides. Van Arkel, de Boer and their associates in the laboratory of the Philips Lamp Works, in preparing single crystals of hafnium metal by a very ingenious method, obtained a separation by precipitation of the phosphates. The close chemical relationship between the compounds of zirconium and hafnium is also shown by the fact that no chemical reaction is known which would be shown by one of these elements and not the other, and also that zirconium never occurs in minerals without hafnium and *vice versa*. This close similarity was not expected by us when we started our search for missing element 72; although, as was shown a few years later by the present writer, such similarity is to be expected on the basis of the quantum theory of atomic structure.

The chemical character of an element is defined, according to Bohr's views, by the charge on the nucleus of the atom and the attraction exerted by the charge on the electrons of the outermost shell. An increase in the nuclear charge without a change in the arrangement of the electrons has the effect of binding the outer electrons more tightly and the atom becomes less basic. In the vertical groups of the Mendejeleff system such an increase in charge takes place from the lower to the higher elements, but at the same time the valency electrons are displaced

further and further from the nucleus into quantum orbits of higher quantum number. On account of this fact the increased attraction—which is an effect of the increase in the nuclear charge—is actually overcompensated by the greater distance of the outer electrons from the nucleus and the higher members become more basic than the lower. Barium has a nuclear charge 18 units higher than strontium and yet it is the more basic element. In comparing hafnium with zirconium we find a difference in nuclear charge of 32 units, much more than in the case of barium and strontium, while the difference in the quantum number of the orbits is the same in the two cases. In comparing barium and strontium with zirconium and hafnium we have in both cases the same difference in the quantum number of the valency electrons, but in the latter case the much greater difference in nuclear charge, 32 units, can no longer be compensated by the increase in the quantum number of the valency electrons and hafnium is therefore but inappreciably more basic than zirconium. We can always imagine two atoms of very different nuclear charge showing practically the same chemical behaviour provided that the quantum numbers of the valency electrons differ sufficiently to compensate exactly for the difference in nuclear charge.

The next question which occurs is: why has hafnium a nuclear charge so much larger than zirconium? The difference is due to the presence of the 14 rare earth elements before hafnium. That the appearance of the rare earth elements is responsible for the extreme similarity between zirconium and hafnium becomes apparent when we try to draw up a fictitious periodic table containing no rare earth elements and deduce the properties of the element that would follow lanthanum in such a table. After lanthanum there would be a "pseudo-hafnium," a "pseudo-tantalum," a "pseudo-tungsten" and so on. These pseudo-elements would all be more reactive than the genuine ones because their valency electrons would be less tightly bound. "Pseudo-hafnium," would have a density of 9 instead of 13, "pseudo-tantalum" 14 instead of 17, "pseudo-tungsten" 15 instead of 19. Although these pseudo-metals are a mere fiction their compounds are not fictitious. The quadrivalent compounds of "pseudo-hafnium" are known and in fact are identical with the ceric compounds. This is obvious from a simple inspection of the electronic grouping shown in the following table.

TABLE.

Electronic Arrangement showing the Identity Cerium^{++++} and Pseudohafnium^{++++}.

Hafnium								Hafnium^{++++}							
N				Q			P	N				Q			P
s	p	d	f	s	p	d	s	s	p	d	f	s	p	d	s
2	6	10	14	2	6	2	2	2	6	10	14	2	6	–	–

Pseudohafnium								Pseudohafnium^{++++}							
N				O			P	N				O			P
s	p	d	f	s	p	d	s	s	p	d	f	s	p	d	s
2	6	10	–	2	6	2	2	2	6	10	–	2	6	–	–

Cerium								Cerium^{++++}							
N				O			P	N				O			P
s	p	d	f	s	p	d	s	s	p	d	f	s	p	d	s
2	6	10	1	2	6	1	2	2	6	10	–	2	6	–	–

As is to be expected, the anomalous behaviour of the ionic sizes of the oxides disappears if we replace the hafnium ion by the ceric ion. This observation is not without interest in connection with the earlier, apparently insuperable, difficulty of deciding whether to place cerium in the third or in the fourth group of the Periodic Table. The cerium atom and the cerous ion are not directly related to zirconium, but the ceric ion is the pseudo-homologue of the zirconium ion. Similarly the quinquevalent praseodymium ion would be the pseudo-homologue of the niobium ion.

The investigation of a very large number of zirconium minerals and also of rock samples led to the result that hafnium always accompanies zirconium in nature. Zirconium is chiefly found as zircon and in most cases the hafnium oxide content of zircon is 1·5 to 2·5 gm. hafnium oxide in 100 gm. $ZrO_2 + HfO_2$. From the above

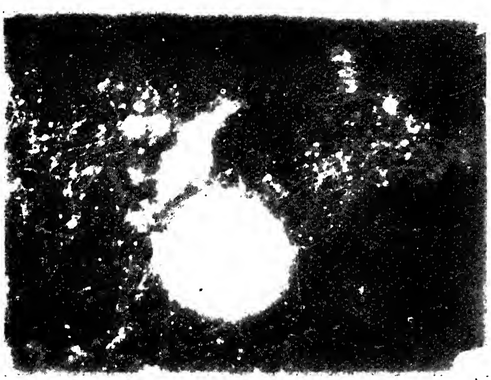
figures and also from analysis of the hafnium-zirconium ratio in meteoric stones, it follows that in the fluid-gaseous stage of our solar system a zirconium-hafnium ratio of about 60 : 1 prevailed throughout and, on account of their similarity, the same ratio is found in present lithosphere. About 1/200,000 part of the earth crust is built up of hafnium, the terrestrial abundance of the latter being as large as that of arsenic, molybdenum or tin.

Hermaphroditism in *Dasychone cingulata*, Grube.

By R. Gopala Aiyar and M. K. Subramaniam.

(*From the University Zoological Research Laboratory, Madras.*)

DASYCHONE CINGULATA occurs in large numbers attached to the buoys in the Madras Harbour in the 'tank' in front of the Yacht Club. While studying its oogenesis[1] and its anatomy[2] male worms were not seen in the collections. This led to a doubt that it may be hermaphrodite and the occurrence of groups of small cells resembling spermatocytes only confirmed our suspicions. In Champy fixed material, careful differentiation and counterstaining often showed some tail-like structures but in all such cases the head was devoid of any detail. Examination of fresh material under very high magnification revealed occasionally what appeared to be sperms. To verify the discovery we examined the cœlomic content under dark ground illumination. Innumerable sperms occur in each segment along with oocytes in various stages of development. The sperms are minute and the tails very slender (photomicrograph).



After examination of the contents under dark ground illumination a change to ordinary light by a change of condenser reveals only a few sperms and that after very careful scrutiny.

In fixed preparations, except in the first four and the last few, all the segments contain both developing oocytes and spermatocytes, which float freely in the cœlomic fluid. The animal appears to breed throughout the year and no special abundance of either of the sexual products was observed in any particular season.

Since the publication of the list of hermaphrodite polychætes by Johnson[3] only a few forms seem to have been added. We are giving below a list of the known hermaphrodite Polychætes which have come to our notice in the literature available to us.

Hermaphroditism occurs in Polychæta without any discoverable cause and is not confined to any one family or any one group of related families. *Branchiomaldane vincenti* and *Lycastis quadraticeps* are considerably smaller than their immediate allies; but their ova are much larger than those of their diœcious relatives. This increase in size of their ova is not followed by any complexity of organisation or any real advance towards higher plane of being. In fact both *Branchiomaldane* and *Lycastis quadraticeps* are of comparatively simple organisation. Ashworth[4] remarks in the case of *Branchiomaldane vincenti* "In particular, the occurrence of hermaphroditism affords strong evidence of departure from the primitive condition; for hermaphroditism is secondary in Polychæta as it is in Mollusca. This seems clear for, at least, two reasons: (1) because of the few cases of hermaphroditism—only about a score of species—known in Polychæta and (2) because hermaphroditism is generally associated in members of this order, with some obviously secondary modification of structure or mode of life. About half the known hermaphrodite Polychæta are tube-dwelling Sabelliformia while most of the others are Polychætes of unusually small size and simplified structure,—*e.g.*, *Lycastis quadraticeps*, *Ophryotrocha puerilis*. In *Branchiomaldane* hermaphroditism is associated with sedentary habits (as in the case of hermaphrodite Serpulids *Spirorbis* and

List of Hermaphrodite Polychætes.

Name of Species	Family	Finder	Remarks	Reference
Nereis diversicolor	Nereidæ	..	..	..
Platynereis dumerili	..	Caullery et Mesnil.	Incipient. Occasionally Hermaphrodite.	*Ann. d. l'Univ. d. Lyon.*, 1898, **39**, 200.
Lycastis quadraticeps	..	Johnson, H. P.	Giant eggs. Male and female in middle segments.	*Biol. Bull.*, 1908, **14**, 371.
Lycastis indica	..	Aiyar, R. G.	Male and female cells in all segments except in front and behind.	*Curr. Sci.*, 1935, **3**, 367.
? *Lycastis hawaiiensis*	..	Horst, R.	Only egg bearing individuals have been recorded.	*Extrait du department de l'Agriculture aux 'Indes Niederlandaises'*, 1909, **25**, **1**.
Lycastopsis catarractarum	..	Feuerborn, H. J.	..	*Verhandl. d. Int. Vereinigung Fur Theor u. Angew. Limnologie*, 1932, **5**.
Macellicephala violacea	Aphroditidæ	Wiren, A.	Hermaphroditism incipient. Males and females occur.	*Zoolog. Studier. Upsala.*, 1902, 289.
Syllis corruscans	Syllidæ	Haswell, W. A.	Anterior somites with eggs and posterior with sperms. Male and female buds occur.	*Proc. Linn. Soc., N S.W.*, 1885, **10**, 733.
Pionosyllis Neapolitana	..	Goodrich, E. S.	Three anterior segments male and several posterior segments female.	*Quart. Journ. Micros. Sci.*, 1930, **73**, 652.
Grubea protandrica	..	Du Plessis.	..	*Rev. Suisse. Zool.*, 1908, **16**.
Grubea pussilloides	..	Haswell, W. A.	Two anterior male segments and several posterior female segments.	*Jour. Linn. Soc.*, 1918, **34**.
Ophryotrocha puerilis	Lumbriconereidæ	Korschelt, E.	Protandric with hermaphrodite organs.	*Zeit. f. wiss. Zool.*, 1894, **57**, 224.
Subella microphthalmia	Sabellidæ	Gregory, L. H.	Protogynous—paired hermaphrodite organs.	*Biol. Bull.*, 1905, **9**, 285.
Dasychone cingulata	..	Aiyar, R. G., and Subramaniam, M. K.	Male and female cells in all segments except in front and behind.	*Current Science.*
? *Caobangia billeti*	..	Giard, A.	Only egg-bearing worms have been observed.	*C. R. Soc. Biol.*, 1893, V Ser. **9**, 473.
Amphiglena armandi	Eriographidæ	Claparede, E.	..	*Mem. Soc. Phys. Geneva*, 1868–70, **19–20**, **1**.
Spirorbis borealis	Spirorbidæ	Schively, M. A.	Female cells in first two abdominal segments. Male in posterior abdominal segments.	*Proc. Acad. Nat. Sci. Philadelphia*, 1897, 153.
Spirorbis lævis	..	Claparede, E.	..	*Mem. Soc. Phys. Geneva*, 1868–70, **19–20**, **1**.
Spirorbis pagenstecheri	..	Pagenstecher, H. A.	Female cells in the middle segments and male cells behind.	*Zeit. f. wiss. Zool.*, 1863, **12**, 486.
*Salmacina dysteri Filograna implexa**	Serpulidæ	Huxley, T. H.	Male gonads 3–5 anterior segments. Female 8–20 segments.	*Edin. New Phil. Journ.*, 1855, **1**, 113.
Salmacina ædifficatrix	..	Claparede, E.	Ova in anterior abdominal segments. Sperms in posterior ones.	*Mem. Soc. Phys. Geneva*, 1868–70, **19–20**, 1.
Salmacina incrustans	..	..		..
Pileolaria militaris	..	..		..
Hesione sicula	Hesionidæ	Bergman, W.	With paired hermaphrodite organs.	*Zeit. f. wiss. Zool.*, 1902, **73**, 278.
Branchiomaldane vincenti	Arenicolidæ	Ashworth, J. H.	Male and female elements in middle segments. Giant Ova.	*Proc. Roy. Soc. Edin.*, 1912. **32**, 62.

* G. H. Faulkner[9] thinks with M. Intosh that *Salmacina dysteri* and *Filograna implexa* are synonymous.

Salmacina), and with small size and comparatively simple external form, and may be safely regarded, as in other cases mentioned above, as a secondary character." As *Lycastis indica*[5] which is also hermaphrodite is not " of unusually small size and simplified structure". It is doubtful whether such organisation is a prime necessity for the hermaphrodite condition. *Dasychone* is a tube dweller, but we are of opinion that tube-dwelling may form only one of the many predisposing causes. A search through the literature on hermaphrodite Polychætes reveals that little attention has been paid to the habitat of the animals. Haswell records in the case of *Syllis corruscans* that in specimens obtained between tide marks at Port Jackson in the month of August the posterior orange coloured male region contained only imperfectly developed testes while in specimens taken from deeper water " the posterior orange coloured region was found to be considerably longer ; in most it had developed on its first segment two pairs of large eyes, and frequently was found altogether detached from the female." Is this difference caused by the difference in the environmental conditions ?

Dr. R. Horst[6] mentions that the genus *Lycastis* is characterised by the facility with which they accommodate themselves to water of greatly reduced salinity. " For, of eight species belonging to this genus five are living in brackish or fresh-water whereas one of them has a strictly fresh-water habitat." In the fresh-water forms Horst observed ripe eggs but no spermatozoa. A re-examination of the sperms of *Lycastis* by us reveals that it is very minute being smaller in size than those of *Dasychone*. It is quite possible that Dr. Horst's failure to see spermatozoa may be due to their minute size. In a footnote to Dr. Horst's paper it is mentioned that *Lycastis hawaiiensis* in the Botanical Gardens at Buitenzorg may have been brought over from the sea along with mangrove plants. " If so, then it is no doubt a very remarkable fact that where in the last two years no mangrove plants have been brought from the sea to our gardens, these worms were able, not only to maintain themselves but even to multiply in these to them quite new surroundings."

We believe that environment and sedentary habits have contributed to the evolution of the hermaphrodite condition. Definite details of the habitats of most of the hermaphrodite Polychætes recorded are unfortunately lacking and our suggestion based on the observations of the habitats of *Dasychone* and *Lycastis* can only be tentative. Brackish water inhabitants show peculiar adaptations associated with reproduction and it is quite probable that a brackish water habitat with fluctuating physico-chemical factors may be responsible for hermaphroditism. In this connection it is remarkable that absolutely nothing is known about the reproductive habits of *Lycastis*. Whether in the brackish and fresh-water forms other modifications affecting reproduction have followed hermaphroditism is not known and a knowledge of it would be of absorbing interest. *Lycastis* has been collected only from the brackish waters of Madras while *Dasychone* which occurs in the Madras Harbour has been collected mostly from the still waters of the ' tank ' in front of the Yacht Club where the water exhibits wide fluctuations in its physico-chemical factors, especially during the rainy season.

Pflugfelder[7] in a recent paper describes some new land Polychætes belonging to the genera *Nereis*, *Lycastis* and *Lycastopsis* from Sumatra. One characteristic of these so-called land Polychætes is the enormous development of the mucous glands as seen also in *Lycastis indica*. *Lycastopsis amboinensis* is terrestrial, but *Lycastopsis catarractarum* (Feuerborn[8]) is hermaphrodite and occurs in fresh-water in Java and Sumatra. As most Oligochæta are brackish water, fresh-water and terrestrial in distribution is it not possible that the hermaphrodite condition originated during adaptation to their new habitats through greatly fluctuating environmental conditions ?

BIBLIOGRAPHY.

1 Subramaniam and Gopala Aiyar, *Proc. Ind. Acad. Sci.*, 1936, **3**, 175.
2 Sankara Menon and Gopala Aiyar, Unpublished.
3 Johnson, *Biol. Bull.*, 1908, **14**, 371.
4 Ashworth, *Proc. Roy. Soc. Edin.*, 1912, **32**, 62.
5 Gopala Aiyar, *Curr. Sci.*, 1935, **3**, 367.
6 Horst, *Extrait du Department de l' Agriculture aux 'Indes Niederlandaises'*, 1909, **25**, 1.
7 Pflugfelder, *Zool. Anz.*, 1933, **105**, 65.
8 Feuerborn, H. J., *Verhandl. d. Int. Vereinigung fur theor. u. angew Limnologie*, 1932, Bd. **5**.
9 Faulkner, *Proc. Linn. Soc. Zool.*, 1930–31, **37**, 109.

LETTERS TO THE EDITOR.

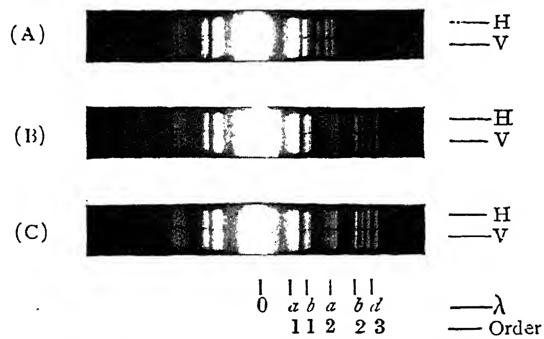
CONTENTS.

Diffraction of Light by Ultrasonic Waves: A Test for Polarisation.

WHEN a beam of light passes normally through a column of liquid traversed by high frequency sound waves, it spreads into a fan of diffraction spectra. The recent theoretical papers of Raman and Nath[1] indicate clearly that this phenomenon is a transmission effect. It has also been shown by the author[2] that at oblique incidences, the light undergoes characteristic reflections in accordance with a simple formula of the Bragg type. In either case, transmission or reflection, theory does not indicate any appreciable polarisation of the diffraction spectra, provided the angles of diffraction are small.

To test this point, experiments were conducted with a double-image prism interposed between the cell and the photographic plate and so oriented as to give the two images side by side. Tests were made both for normal and oblique incidences of the light beam to the sound wave-front and at frequencies of $7 \cdot 164 \times 10^6$ and $20 \cdot 00 \times 10^6$ c./s.

No polarisation of the lines, either for different wave-lengths of light or for the different orders could be detected. The photograph given above shows this fact clearly.



Polarisation of lines in the diffraction spectra at 20 Mc, taken in *m*-xylene.

(A) at normal incidence; (B) & (C) at inclinations.

(*a*) .. Group of 3 Hg. lines 3650, 4046, 4258 A

(*b*) .. Group of 2 Hg. lines 5461, 5770 A

(*c*) .. Group of 2 Hg. lines 4046 and 4358 A

S. PARTHASARATHY.

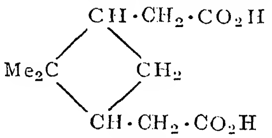
Indian Institute of Science,
Bangalore,
November 11, 1936.

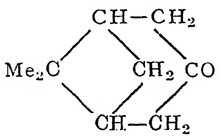
[1] Raman, C. V., and Nagendra Nath, N. S., *Proc. Ind. Acad. Sci.*, 1936, **3**, 459, and earlier papers. A generalised theory is given by Nagendra Nath, N. S., *Ibid.*, 1936, **4**, 222.

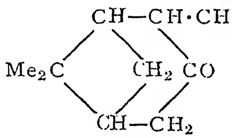
[2] Parthasarathy, S., *Ibid.*, 1936, **3**, 594.

The Synthesis of *trans sym.*-Homopinic Acid.

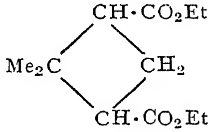
THE Synthesis of *trans sym.*-Homopinic Acid (I) has now been effected in the course of our attempts to synthesise *iso*nopinone (II) and pinocamphone (III).

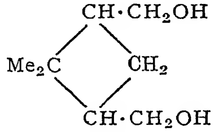

(I)

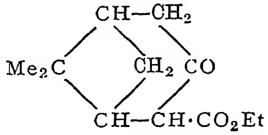

(II)


(III)

Ostling[1] reduced *cis*-diethyl norpinate (IV) by means of sodium and absolute alcohol and obtained the glycol (V), b.p. 150–52°/15 mm.; but no details of his experiments and yields are available. It has now been found that reduction with sodium and absolute alcohol at 140° (Ostling's condition) gives the glycol in about 10–20 per cent. yield together with some by-products, whereas by adding sodium all at once to the ester in absolute alcohol (moisture less than 0·01 per cent.) obtained according to the method of Manske[2] the glycol is obtained in about 75 per cent. yield with no by-products. The significant observation is made that both the *cis*- and *trans*-esters furnish the same glycol, b.p. 125–28°/4 mm. (identical with that of Ostling) which has now been proved to be of the *trans*-configuration by oxidation with permanganate to *trans*-norpinic acid. With PBr_3 in dry chloroform solution the glycol gives the corresponding dibromide, b.p. 100–102°/4 mm. with a very characteristic terpene like odour. This on refluxing with alcoholic sodium cyanide for 12 hours gives

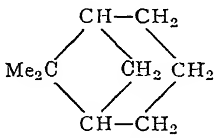

(IV)

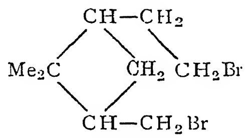

(V)

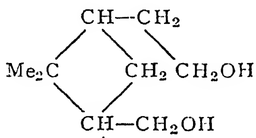

(VI)

the corresponding dinitrile, b.p. 142–45°/6 mm., which on hydrolysis with boiling 20 per cent. potash yields *trans sym.*-homopinic acid, m.p. 120–21° (dianilide, m.p. 219–20°). This acid is remarkably stable, distilling unchanged over barium hydroxide. With acetic anhydride under the usual conditions (Blanc) it does not give a ketone but only the double anhydride[3] which with water gives the acid (I). The diethyl ester of (I), b.p. 131–32°/4 mm. gives on prolonged boiling with sodium in xylene solution traces of a product exhibiting properties of a β-ketonic ester. The cyclisation does not proceed in the desired direction to yield the ester (VI) obviously due to the acid (I) possessing the *trans*-configuration. A study of the model also shows that the formation of the bi*cyclo*-(1 : 1 : 3)-heptane ring by the locking of the *trans* valencies in 1 : 3-positions of *cyclo*butane is not possible.[4]

In the light of the results obtained in this investigation, Ostling's failure (*loc. cit.*) in getting nopinane (VII) from the dibromide (VIII), can reasonably be explained as due to his glycol (IX) being of the *trans* form


(VII)


(VIII)


(IX)

the change of configuration occurring during the reduction of pinic ester with sodium and alcohol. Work on the synthesis of *cis-sym.*-homopinic acid is in progress.

This work was done with experimental collaboration of Messrs. D. K. Sankaran and V. K. Subramanian.

P. C. GUHA.
K. GANAPATHI.

Department of Organic Chemistry,
Indian Institute of Science,
Bangalore,
October 31, 1936.

Prospects of Power Alcohol in India.

IT will be recalled that as a result of the Sugar Conference held at Coimbatore in November 1933, the Government of India sanctioned the use of 50,000 gallons of alcohol for motor fuel as an experimental measure. The Mysore Sugar Company who conducted the experiment have completed the quota a few months ago; and it is hoped that their experience with the scores of cane lorries running on alcohol has been promising.

In recent months the question of power alcohol from surplus grain has engaged the attention of the United States Government as a means of farm recovery, and, in the very teeth of powerful oil interests, commercial demonstration has been undertaken by the Chemical Foundation who put up a 10,000 gallon distillery at Atchison. In view of this development, despite the cost of their raw material and the magnitude of home production of gasoline, one finds it difficult to understand the lack of initiative in India in the matter of utilising waste molasses for the production of motor fuel.

There have been several proposals for the economic disposal of molasses; but so far the main outlet in the Indian sugar factories has been the waste gutters or sale for export nearly free of cost. It is hardly necessary to point out that none of the methods of disposal suggested could approach in economic value the production of 40 gallons of motor fuel, 300 pounds of carbon dioxide, 75 pounds of fertilising material and 50 pounds of fodder yeast from every 100 gallons of molasses.

Various objections against the use of alcohol in automobile engines have been largely answered or overcome. The author is aware of a series of carefully conducted tests in Mysore with a 6-cylinder car with normal compression running 20 miles per gallon with petrol fuel and 22 with 96 per cent. alcohol. And it is well known that higher compression enhances the efficiency of alcohol, 38–40 per cent. thermal efficiency being feasible at 180–200 lb. per sq. in. as against the 26–28 per cent. that usually obtains in the motor engine running on petrol.

The much talked of difficulties facing denaturation and excise supervision are hardly real, in so much as the United States Government has developed denaturants that apparently have been found satisfactory. There are administrators who refuse to accept petrol as an effective denaturant but, considering the demands that have been in successful use under every conceivable climatic condition, it may not be an insuperable task to devise denaturants to the entire satisfaction of the excise authorities in India. The decision of the Government of India in a matter that has an obviously vital bearing on the future of the sugar industry will be therefore awaited with keen interest.

A. L. SUNDAR RAO.

Allahabad University,
October 10, 1936.

Mutual Aid Society for Scientific Workers in India.

IN view of the great difficulties encountered by scientific workers in India regarding money for purchase of apparatus, books, etc., I think, that a Society should be started on the lines of the German *Notgemeinschaft der Deutschen Wissenschaft*. This Society was started immediately after the Great War to help German scientific workers and has become an invaluable and irreplaceable limb of German scientific activity. The funds for it are obtained by general subscription from all workers (roughly a *mark* or two per month), from industrial concerns, the Universities and from the Government. Any apparatus or book purchased is the property of the Society and is accordingly labelled. These are sent from person to person and from place to place according as the need for them arises. There is a general Governing Council of many eminent men who deal with questions regarding the urgency and necessity of each demand. I hope this idea will catch the mind of scientific men in India and induce them to form a mutual aid society.

N. G. CHOKKANNA.

Indian Institute of Science,
Bangalore,
November 9, 1936.

ASTRONOMICAL NOTES.

1. **Occultations of Stars by the Moon.**—Observations of lunar occulatations provide an accurate method for determining the errors in the tabular places of the Moon. For the last ten years Prof. Brown and Dirk Brouwer have regularly compiled the observations of occultations made at various places and from a discussion of the results have derived the mean difference for each year of the mean longitude of the moon from the value given in the ephemeris. *Astronomical Journal* 1053 contains a paper by the same authors where 1483 occultations observed in 1934 have compiled and discussed. Observations of only disappearances at the dark limb have been used in the discussion. The mean value deduced for $\delta\lambda$ is $+3''.85$, *i.e.*, the amount by which the Moon was ahead of its tabular longitude.

2. **Proper Motions of Stars.**—A knowledge of proper motions of stars plays an important part in investigations on the structure of the sidereal universe. The Hamburg Observatory has recently issued an exhaustive publication *Bergedorfer Engenbewegungs-Lexikon*, in two volumes, containing all known proper motions of stars down to the ninth magnitude in both the northern and southern hemispheres. The proper motions are taken from various sources and have been derived from meridian observations as well as from measures on photographic plates. Besides the authority for the motion, are given the magnitude of each star and where available the spectral type from the *Henry Draper Catalogue*.

3. **Absolute Magnitudes of Stars of Large Proper Motion.**—With the accumulation of parallax observations of stars of large proper motion, the absolute magnitudes of a number of such stars have been determined with some accuracy. On the basis of these data van Maanen has studied (*Publications of the Ast. Soc. of the Pacific*, August 1936) the distribution of absolute magnitudes of stars with proper motion larger than $0''.5$ annually. Combining this result with that found for faint stars with annual motion between $0''.1$ and $0''.5$ in the fields of the "selected areas," he concludes that the maximum of the frequency curve of the absolute magnitudes of stars with large proper motion cannot be fainter than $+10.5$ magnitude—corresponding to a luminosity of .0055 of the Sun.

4. **A White Dwarf Star.**—From spectroscopic observations at Mount Wilson, the star Ross 627 is found to be a white dwarf. Its position is given by R.A. 11h. 19.1 m. and Decl. 21° 55′ N and it has a proper motion exceeding one second of arc annually. The spectrum is of type A_0 with wide shallow lines; some interesting details are given in *P. A. S. P.*, June 1936. The star is a faint one of 14.1 photographic magnitude and the distance derived from the parallax measures of van Maanen is about 11 parsecs. The corresponding absolute magnitude is $+13.8$ indicating that the star is one of the faintest white dwarfs known.

5. **Variable Stars of R Coronae Borealis Type.**—There is a class of irregular variables comprising stars which are ordinarily of uniform brightness, but sometimes decrease suddenly in brightness and vary irregularly until they regain the normal maximum. The recovery of brightness takes a considerably longer time than the drop to minimum. In a short note published in *Harvard Bulletin* 903, C. P. Gaposchkin discusses the spectral characteristics of this type of stars. They are generally of spectral class G, K or R and are found to have an abnormally large amount of carbon in their atmospheres. Typical examples of this kind of stars are R. Ooronœ Boronœ Borealis, R Y Sagittarii and S U Tauri.

T. P. B.

CENTENARIES.

S. Ranganathan, M.A., L.T., F.L.S.

Fordyce, George (1736-1802).

G. FORDYCE, the Scottish physician, was born at Aberdeen on 18th November 1736. While his father was one of twenty children, he was the only and posthumous son of his father. He took the M.A. of Aberdeen in his fourteenth year and entered as a medical student in the University of Edinburgh. He graduated M.D. in 1758 and studied for a year at Leyden.

As a Teacher of Medicine.

At that time regular medical schools did not exist. The students had to depend on private tutors. Mr. Fordyce resolved to make his living by giving lectures to medical students. Accordingly, he commenced a course of lectures on chemistry in 1759 and in 1764 added courses on materia medica and the practice of physic. He continued these courses for nearly thirty years. They were extremely popular. Thousands of students attended them. Some of them became distinguished in their later life. Although his lectures were based on his *Elements of Practical Physic.* 2 V, 1768, which went through several editions, they were said to have been remarkable for rather elaborate logical analysis. Several full copies of notes by his pupils are said to exist still in manuscript.

His Contributions.

He was admitted Licentiate of the College of Physicians in 1765 and became Physician of St. Thomas's Hospital in 1770. He held this latter office till his death. He took an important part in the compilation of the *Pharmacopeia Londinensis* which was issued in 1788. In 1793 he promoted the formation of a Society for the Improvement of Medical and Chirurgical Knowledge. He contributed frequently to the *Transactions* of this Society and to the *Philosophical Transactions* of the Royal Society. The reputation of Fordyce as a medical man rests on his two books *Treatise on Digestion* (1791) and *Dissertations on Fever* (1794–1803). Rejecting all mechanical theories, he treated digestion as a physiological process. His observations on the temperature of the human body were numerous and historically important. He devised experiments to show that the body preserves a constant temperature even in heated rooms. His other publications consist of eleven papers and two books.

Conclusion.

He was elected a Fellow of the Royal Society in his fortieth year. His interests went far beyond medicine. Some of his papers refer to metallurgy, mineralogy, pendulum motion and latent heat and pure chemistry. He worked hard throughout his life. He had conceived the idea that men ought to eat only once in the day and he practised it. He died on 25th May 1802.

McAdam, John Laoudon (1756-1836).

J. L. McADAM, the "macadamiser" of roads, was born at Ayr in Scotland on 21st September 1756. His forefathers had been breaking new ground from time to time. They belonged to the clan of McGregors, which, when outlawed by James II, changed its name to MacAdam. John's father founded the first bank in Ayr in 1763. While an infant, McAdam narrowly escaped death in a fire which consumed his father's house. While studying at the parish school of Maybou, he is said to have given signs of his future eminence as a roadmaker by constructing a model section of a road of the parish.

Sojourn to America.

On the death of his father in 1770, he was sent to New York to learn business under his uncle, who was a merchant. While at New York, he accumulated a considerable fortune and returned home in 1784 and settled down in an estate in Ayrshire. For fourteen years, he lived as a country gentleman and magistrate.

His Discovery.

During this period he was also holding the place of a road trustee. He used this capacity to investigate the conditions of the highways. By many years of careful observations and experiments, he discovered the method of making broken-stone roads. The surface of the ground on the track of the intended roads was to be raised slightly

above the adjoining land; suitable drains were to be formed on each side of the track; it was to be covered by a series of thin layers of hard stone broken into angular fragments of a nearly cubical shape, and as nearly as possible of the same size; no piece was to weigh more than six ounces; the layers of broken stone were to be consolidated gradually by passage of traffic over the road and the covering of the road would thus become a firm and solid platform, nearly impervious to water and durable in proportion to the hardness of the stone of which it was made.

PUBLIC APPROVAL.

McAdam first published an account of this method in a communication addressed to a committee of the House of Commons in 1811. He afterwards wrote a treatise on the subject which went through several editions and was translated into many languages. In 1815 McAdam became Surveyor-General of the Bristol Roads. By 1823 the success of the macadamisation of highways was generally recognised. McAdam's efforts largely contributed to produce the network of mail coach communication, which for some years before the railways were introduced, greatly advanced the nation's prosperity. McAdam's process was adopted in all parts of the civilised world.

PUBLIC RECOGNITION.

On learning that between 1798 and 1814, McAdam had, at his own expense travelled over 30,000 miles of roads in order to pursue his investigations, had spent 2,000 days on these tours and had spent nearly £5,000 of his private money, a committee of the House of Commons of 1823 voted for him an indemnity and a gratuity amounting to £10,000. In 1827, McAdam was appointed General Surveyor of Roads. Besides these, he was offered a knighthood, which he declined. But at his request, the knighthood was conferred on one of his sons, Sir James McAdam, who assisted and succeeded him as a road engineer. McAdam's name has been made immortal in literary English by Southey, Bentham and many others.

While returning from a visit to Scotland, he died at Moffat on 26th November 1836.

Hutton, Frederick Wollaston (1836-1905).

CAPTAIN F. W. HUTTON, the British naturalist, who did poineering work in constructing the Natural History of New Zealand, was born at Gate Barton, Lincolnshire on 16th November 1836. His father was the Rector of the village. Educated at Southwall and the Naval Academy, Gosport, he joined the Indian mercantile marine at the age of fourteen. Having been a midshipman for three years, he left the sea and enrolled himself at the King's College, London. But before the age of twenty he received a commission in the army, became Lieutenant in 1857 and Captain in 1862. He saw service in the Crimea in 1855–56 and subsequently in India during the Sepoy Mutiny, where he shared in the capture of Lucknow and in the defeat of the Gwalior mutineers by Lord Clyde, receiving medal for both campaigns. In 1860–61, he passed with distinction through the Staff College, Sandhurst. The lectures on Geology, delivered by Prof. Rupert Jones in that college, disclosed his bent for science which made him retire from the army in his thirtieth year and migrate to New Zealand in search of opportunity for scientific work.

HIS SCIENTIFIC CAREER.

After unsuccessful farming for a few years, he joined the New Zealand Geological Survey in 1871 as an Assistant Geologist. In 1873, he became Provincial Geologist of Otago and Curator of the Museum. In 1877, he became Professor of Natural Science in the Otago University. In 1890, he was appointed Professor of Biology and Geology in the Canterbury College of the University of New Zealand. He relinquished this post in 1893 to take up the position of Curator of the Christchurch Museum, which he held till his death.

HIS CONTRIBUTIONS.

His knowledge of New Zealand was very wide and not less so was the range of his scientific writings, which were more than a hundred in number and which were chiefly geological, in addition to thirteen official catalogues, of fishes, mollusca, crustacea, worms, echimoderms, sea-anamones and insects. Most of his papers appeared in the *Transactions* of the New Zealand Institute. He also contributed to the *Geological Magazine* and some other British periodicals. He was also the author of *A Class Book of Elementary Geology* (1875), of *Darwinism and*

Lamarckism (1899) and *Indix fauna Novæ Zealandæ* (1904), *Lassons of Evolution* (1902) and *Animals of New Zealand* (1904).

HIS HONOURS.

As early as 1861, he was elected a Fellow of the Geological Society and in 1892 his strenuous work on the Natural History of New Zealand got him the Fellowship of the Royal Society. He became President of the Australasian Association for the Advancement of Science, in 1901 and was the first President of the New Zealand Institute. His review (1861) of the *Origin of Species* gained from Charles Darwin an appreciative letter, of which Hutton was justifiably proud. His contributions to the origin of New Zealand fauna and flora made him known throughout the world as a recognised authority on all matters connected with the geographical distribution of animals and plants.

AS A TEACHER.

As a teacher, he was singularly clear and original in his methods of exposition and possessed valuable faculty of arousing enthusiasm in his pupils, several of whom became contributors to various departments of natural science. Being thoroughly sincere, open and straightforward in all his actions, he was a keen and inspiring critic of anything that bordered on pretence and humbug. After forty years' absence in New Zealand, he came to England in 1905 for a short stay. While on his way back to New Zealand, Hutton died at sea on October 27, 1905.

Twentieth Century Psychiatry.*

THIS book is a compilation of three lectures delivered by Dr. William White of Washington, under the auspices of the Salmon Memorial Trust, at the New York Academy of Medicine in 1935. Dr. Thomas W. Salmon in whose memory the Trust is founded, was the Medical Director of the National Committee of Mental Hygiene, and piloted it successfully through many difficult years. A relevant extract from *The American Journal of Psychiatry* (1931, page 725) regarding the Trust reads as follows :—

> "A meeting in memory of Dr. Thomas W. Salmon was held at the New York Academy of Medicine on Saturday evening, January 10, 1931. At this meeting the completion of the fund of a hundred thousand dollars which was raised by friends and admirers of Dr. Salmon was announced. The custody of this fund has been vested in the New York Academy of Medicine, and the lectures will be delivered under its auspices and the lecturer selected annually by the Academy, and a special Advisory Committee. Under the terms governing the Trust, a scientific worker who has made outstanding contribution to Psychiatry, Mental Hygiene, or a related field must be chosen to deliver the lectures."

Dr. White is the third lecturer of the series, the two previous lecturers being Dr. Adolf Meyer of Johns Hopkins, and Dr. McFie Campbell of Harvard. These three are the senior accredited representatives of American Psychiatry. Their scientific contributions have embraced the whole field of psychiatric thought. Their students are to be found in every Clinic or University of any importance. The writer of this article had the good fortune to be a student of one of them.

Dr. Meyer lecturing on 'Psychobiology' stressed a point of view, of which he is the chief exponent. Dr. Campbell lecturing on 'Destiny and Disease in Mental Disorder' confined himself more or less to the reaction type usually termed Schizophrenic ; he interpreted the life experiences of such nervous and mental patients, and showed how from such studies, valuable insight could be gained into forces of human nature, the complex texture of personality, and the varied problems of human adaptation. He also warned of the danger of too much emphasis on the experimental method and the neglect of the broader aspects of human individuality.

Dr. White has continued the tradition, but has been more elaborate and comprehensive in choosing for his subject a review in perspective of the whole progress in psychiatric thought during the twentieth century. His three lectures, "Psychiatry as a Medical Speciality," "The Social Significance of Psychiatry," and the concluding one "The General Implications of Psychiatric Thought," deal with a variety

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* *Twentieth Century Psychiatry*. By Dr. William White. (Chapman & Hall, London.) 1936. Pp. 198. Price 10*sh*. 6*d*.

of subjects, Medical, Psychological, Sociological and Philosophic.

It is neither possible nor profitable in a review like this to discuss the various problems raised in the book. It is perhaps more preferable to discuss how far the author's expectations and hopes in presenting these lectures in a book form can be expected to be realised. Dr. White hopes to help the reader in these lectures "to discover gradually unfolding to his vision not only a concept of psychiatry in its more limited sense as a medical speciality, but in that broader sense which relates to it all the other departments of thought and experience," and thus of necessity "he will also discover that there is at the foundation of this presentation a philosophy in accordance with which its details are developed and differentiated." This philosophy, the author hopes, will be found to be helpful not only in the restricted area of the practice of psychiatry but in the whole field of medicine not to say the still broader field of human relations.

At the outset, it cannot be sufficiently emphasised that medicine has a destiny to fulfil as a science, and its function does not end with measures to combat suffering and pain. Therapeutics is certainly a very important aspect of medicine, but it is not all. Viewed from this broader aspect of medicine as a science, it becomes intelligible why the numerous publications and research papers published in recent years deal not with mere therapeutics but with formulations regarding the nature of disease and abnormality in general. In this connection the work of Sir Thomas Lewis is of considerable interest. It is only when considered from this point of view, the value, meaning and purpose of Dr. White's book become evident. Dr. White in his lectures emphasises changing orientations and concepts in psychiatric thought, and does not concern himself with mere evanescent details.

The concept of the organism as a whole opposed to the body-mind division claims his first attention. The terms bodily activities and mental processes are purely different aspects of the activities of the organism, the so-called mental processes being total reaction patterns, while the bodily activities are part-reaction patterns. The mind-body relationship is a unity, but the persistence of these words, body and mind, however, as Dr. White points out, leads to some confusion, because our ways of thinking are imprisoned by the forms of our language. These two words have long meant different entities, and unless we think of a better way of expressing this unity, even hyphenated expressions like emotion-intellect, heredity-environment and of course body-mind, may only serve to emphasise the difference and not the unity as we desire they should.

The studies on personality by Dr. Adolf Meyer, from what he terms the psychobiologic angle, Coghill's biological researches on the behaviour patterns of amblyostoma are concrete verifications of the implications of this concept of organism-as-a-whole. It might be quoted as an example that no type of reaction, however highly specific it might have been thought to be, can ever separate itself from its background, the total behaviour pattern. Secondly, events and responses must be explained by their significance, purpose and ideals; meanings and values are far more important than mere descriptions and classifications.

The psycho-analytic movement is perhaps the most significant single factor which brought about this altered orientation in psychiatric thought—from mere description and classification to meanings and values. The achievements of bacteriology and the progress in microscopic anatomy and pathology on the one hand, and static academical discussions on Psychology on the other, had completely obscured the issues in Psychological medicine. The Physicians and Pathologists were busy on one side groping for a bacterium or a demonstrable pathological structural defect in conditions like mania, melancholia, hysteria, dementia, præcox, etc., which however could not be found, while on the other, the academic psychologists were busy with sterile controversies over non-existent faculties and water-tight compartments of a mythical mind and soul. It was in this big, buzzing, booming confusion that the genius of FREUD BLAZED THE TRAIL.

Dr. White rightly considers that most of the heated opposition roused by Freud's publications was due to their contents, which were sexual, and which were revealed by his analyses. This, Freud could not help, because of the essentially pathological nature of the cases he had for his material. But the methodology he introduced was revolutionary. He contended that the aim of psycho-pathology was to explain the symptoms of abnormal states of mind in psychological terms and not merely to

describe and classify them. Rickmann has observed that up to the time of Freud the tendency of psychiatry has been to turn for help to the physical sciences, which resolve themselves to number, measure and scales. In contrast to this psycho-analysis has another method to offer, which does not enumerate, measure, or weigh; it only deals with presentations in the mind and tries to find by its technique how they are arranged, how they interact, and how they take effect in behaviour. A proper combination of the two methods, Rickmann adds, is the inevitable destiny of psychiatry; at present, there seems no way of fusing the two, so that the Clinician is obliged to use the two alternately, viewing now the Psychical, now the chemical, regarding the patient at one moment ontogenetically, at the next moment as the subject of statistical research. Dr. White, although an ardent believer in psycho-analysis, has, however, no illusions about the same. He recognises that it is only one of the approaches to the problems of the mind, and to its therapeutics. And that the impossible claims made for it by some of its advocates, only hinder its usefulness.

Side by side with the psycho-analytic movement, and as some people seem to think as a corollary of or supplementing the same, arose the Mental Hygiene movement, with its offspring, the Child Guidance Clinic. It is a matter of common knowledge that Clifford Beers (author of *A Mind that Found Itself*) the driving power behind the movement was himself a mental patient, and that his sympathy with the sufferers, and the deplorable manner in which the patients were treated, was responsible for the foundation of this movement which is now a huge international organisation. The Mental Hygiene movement is essentially a public health movement which has as its major objective the prevention of the disabilities and wastage of mental disease. That mental disorder can, to some extent at least, be looked upon as preventable, is a startling innovation. Its sociological and educational implications are obvious. Moreover, it gives a new orientation to the inert notion of the inevitableness of heredity. Both heredity and environment are not any more separate and distinct facts unrelated to each other, but they are just like body and mind, only two aspects of an organism which grows out of and into an ever-changing environment. If we accept that everything abnormal is based upon a hereditary background which determines in its very inception and for all time what its consequences shall be, then there is nothing to be done about mental disease at all. But it is only because, we believe that to some extent at least, we could modify human beings, and that we can remove some of their difficulties and disabilities, we are able to understand the extraordinary, sometimes almost miraculous, therapeutic successes.

Closely associated with this problem of heredity, is the consideration of the physical make up of the individual, which is largely, if not fully hereditary in origin, and which has within it certain corresponding types of thinking and feeling. Kretschmer's work on the close association between the thickset individual and affective disorder, and the asthenic individual with morbid introversion and schizophrenia is too well known to need comment. But both Kretschmer's work on physique and Jung's work on extroversion and introversion, however suggestive, should not be taken too literally. Because clear cut, concrete, and definite psychological or biological entities exist nowhere in the universe. A belief in such represents only the extreme of the wishful attitude of man towards reality.

Before leaving this part of the subject, it is wise to remind ourselves that all these problems of growth and development, psychological and physical, are merely functions of time. The new orientation from purely space thinking to time-space thinking is as significant in psychiatry, as the time-space continuum in fourth dimensional physics.

Dr. White deals also with the influence of psychiatry on criminology, delinquency and education, but what he has said is common knowledge and needs no comment. The contribution of psychiatry to medicine can hardly be too often repeated. A patient is not a more or less incidental container of an interesting biochemical, physiological, or bacteriological situation, but is something far more. A clinical picture is not a mere photograph of a man sick in bed. It is an impressionistic painting of a patient surrounded by his home, his work, his relations, his friends, his joys, sorrows, hopes and fears. A doctor is not treating a disease, is not treating a mere case, but a human being, in whom the importance of psychology is over ninety per cent., and of physiological pathology less than ten per cent.

While these paragraphs were being written two reviews of the same book have appeared, a lengthy one in *Mental Hygiene* of July 1936, and a very short note in the *Lancet* of August 22. While that in *Mental Hygiene* is very fulsome in its praise, the note in *Lancet* is very lukewarm; and hardly just to the author. "He has high hopes of what may be done for civilisation by the use of psychological knowledge; of those major threats, which make optimism difficult for Europeans, he scarcely speaks at all." One often feels that the problems of dictatorship, tyranny, aggression, and of mob hysteria agitating Europe have in spite of a common human background aspects which are purely individual to Europe, and a non-European cannot deal with these problems with the same authority as a European can. What constitutes progress is only a point of view, and Dr. White with his experience of forty years has lectured on what he feels he could speak with authority, on subjects which he thinks need comment, and in a field in which he has not been an idle spectator, in contrast to the many compilers of recent advances. One cannot quarrel with Dr. White on this count.

Just as in other books, which are compilations of lectures, in this book also there seems to be a lack of coherence and sequence; a certain amount of repetition and disproportion. One notes also with regret a tendency to soar from facts to 'beyondness,' in a way out of keeping with past form,—a failing noticeable in many other great men, for example Jeans and McDougall, and latterly in Jung.

Every intellectual revolution which has ever stirred humanity to greatness has been a passionate protest against inert ideas. A great idea in the background of dim consciousness is like a phantom ocean beating up on the shores of human life in successive waves of specialisation. Wholes can no more be studied without reference to parts than parts without reference to wholes. *Twentieth Century Psychiatry* is in large part a contribution by man to a knowledge of himself.

M. V. GOVINDASWAMY.

Senescence and Death in Invertebrate Animals.

THE causes of death in mankind due to disease or old age have been the subjects of investigation by man ever since he began to show scientific curiosity in these phenomena. In his attempts to prolong his wonderfully interesting life, man has wandered into the pathless regions of speculation in regard to life, death and the soul of the individual, and stumbled on the sciences of Chemistry, Biology, Medicine and Hygiene. Man's interest in his domestic pets, chiefly of the mammalian and avian species, led him to investigate the problems of old age and death in Vertebrates other than man, and the phenomena of parasitism and of monstrosity in plants and Invertebrate animals of economic value. Not until recent years, however, was systematic attention focussed on the phenomena of senescence and death in various groups of Invertebrate animals. The great volume of literature on this subject, when critically examined, shows that it is essential to distinguish clearly between two types of data, (1) relating to changes in the organisation of Invertebrate animals due to normal physiological conditions, and (2) relating to changes due to pathological conditions.

What are the signs of senescence observed amongst the Invertebrates of the various phyla of the Animal Kingdom, does senescence actually lead to death in these animals, and what are the various views held in regard to the causes and significance of senescence? Illuminating answers to these questions are given by Dr. István Szabó of Budapest in an excellent summary of the literature on the subject in *Rivista di Biologia*, XIX, Fasc. III, 56 pp. (1935) to which is appended a fairly exhaustive list of references.

There are two fundamental views held in regard to the process of ageing. The earlier view held by Weismann and others was that ageing is a wearing out of the tissues, while the more recent one held by Minot, Baer and others is that it is a part of the developmental process of the animal, or as Raymond Pearl holds that senescence is not an indispensable peculiarity of life. Between these two extremes, and explanatory of the one or the other extreme is a variety of views in regard to the causes of senescence and consequent physiological death. One view is that senescence and death are caused by aggregation of living cells as in multicellular

organisms and by organic differentiation, a second view is that they are brought about by the poisoning influence of metabolism, or by the insufficiency of excretory processes or of metabolism, a third view attributes old age and death to the decay of assimilatory activity, a fourth view to the exhausting effect of the reproductive processes, a fifth view holds that death is an essential aspect of life, a sixth holds the struggle for existence between different parts of the organism as responsible for its old age and death, a seventh attributes senescence and death in animals to the colloid character of living substance. According to the last mentioned view, death of the organism is caused by the increasing density of the protoplasm. Szabó thinks that as each individual repeats the ancestral history according to the Biogenetic law, the colloids thicken gradually leading to senescence. One author atributes the thickening of the protoplasm to the law of gravitation, which holds good for all living matter.

Among Protozoa destruction of the nucleus and other parts of the organism seem to represent the changes due to senescence. The occurrence of peculiar modes of reproduction (by fission and reorganisation) in the Protozoa by which the parent organism divides itself into daughter organisms has earned for this group the reputation of being potentially immortal, but the loss of individuality sustained by the parent organism provides an argument for holding the opposite view. In Protozoa death can only be considered as external, that is to say, Protozoa are exempt from physiological death. Nevertheless, senescence in Protozoa is as much potential as immortality. The classical experiments of Child, Prowazek and others with young and old individuals of various kinds of Protozoa show that they suffer old age without resulting in death, and that the continuity of life is maintained indefinitely by a process of rejuvenation.

In regard to Sponges, Bidder, Minot and Arndt consider that there is no senescence, although degeneration and reduction of parts may take place as a result of starvation or of other unfavourable conditions. Szabó thinks that the question of senescence in sponges can only be settled by further careful observations.

In regard to Coelenterates, the works of Hertwig, Boecker, David, Gross, Hartlaugh and Schlottke are reviewed showing the divergence of opinion amongst authors with reference to the causes of senescence and death. Hertwig observed that the same causes which result in the death of *Hydra fusca* in cultures may also lead to the development of reproductive organs, the only difference between the two phenomena being the degree of intensity of depression in cultures, the greater producing death and the lesser sexual reproduction. Boecker and Goetsch found that organisms in cultures recovered from depression, and therefore considered depression as a sign of pathological phenomenon and of cessation of feeding, bud-forming and assimilation. According to Hartlaub, the approach of death is heralded by the cessation of sexual reproduction. David and Gross thought that *Hydra* was potentially immortal. Schlottke found that all except the interstitial cells in *Hydra* were subject to senescence and death, and the latter category of cells gave rise to other cells. He, therefore, thought that *Hydra* was potentially immortal.

In *Rotifera* the signs of senescence were studied by various authors. Noyes observed in *Proales decipiens* that although old animals fed continuously digestion and defecation did not take place. Jennings and Lynch found that in old *Proales sordida* the movements were slow, feeding process inefficient, and the tendency for the head to get attached by some secretion. Plate observed swelling of the middle parts and the tucking in of the extremeties in *Collidina magna* as the signs of senescence. In *Rotifera vulgaris* Speman found that the signs of old age were creeping instead of swimming, slower reactions to external stimuli, shrinkage of the body and crumpling of the integument, loss of elasticity of muscles, and cessation of reproduction. In *Lecane inermis* Szabó, M., observed slower movements, the tendency to remain rooted to one place for long periods and to fall to a side from which position they cannot raise themselves. The animals, however, fed till death, but stopped defecation 24 hours earlier. In all the species of *Rotifera* studied, ciliary movements in the cells of the Oesophagus and the excretory organs continued till death whatever the changes due to senescence.

In the Nemertine worms Sekera observed decrease in body size and heavy pigmentation of the integument as the signs of senescence.

In the Polychæte worm *Hydroides pectinata*, Harms observed signs of senescence to be less irritability, stagnation of blood in abdominal vessels, irregular peristalsis in the gut, and gradual degeneration of the segments of the abdomen from behind forwards. Provided that the animal is able to get rid of its degenerating abdomen from the thorax, the latter can regenerate a new abdomen. The deeper cause of senescence seems to lie, however, in the central nervous system, in particular the parts which control the blood-vessels, where degeneration sets in while the rest of the tissues are histologically normal. Even after the whole brain has almost degenerated and the cell-outlines are obliterated, irritability seems to persist. Harms did not consider the appearance of pigment in worms, as also in Coelenterates and Arthropods, as a sign of senescence. Stolz observed shrinkage of the body, cessation of budding and degeneration of the digestive system in *Aelosoma hemprichii*. In the asexual oligochætes of all ages (*Nais communis* and *N. variabilis*) Stolte found symptoms of old age in slow movements, in reduction of peristaltic activity in the gut and of pulsation in the blood-vessels, in the flattening of muscle epithelium and muscle layers, in the accumulation of metaplastic material (chloragogen bodies), and in the death of the intestinal and nerve cells. He was of opinion that senescence and physiological death were caused by the discontinuance of the production of reserve cells and by degeneration of the mass of nerve fibrils in the visceral ganglia, although the latter were less striking. Szabó concludes from Stolte's studies that physiological death is caused primarily by degeneration of the gut-chloragogen system.

In Crustacea senescence changes have been observed by Walter in *Cyclops viridis* to begin in the nervous system, chiefly brain, as atrophy of cells, leading to the breaking off of setæ, clumsy and unbalanced movements, and cessation of feeding.

Changes similar to those observed in *Cyclops viridis* were described by one author in the case of Phasmidæ, but these have been contradicted by a later observer. Metschnikoff found in moths cessation of excretion and accumulation of excretory products. Other observers like Krumbiegel, Blunck, Janish, Pixell-Goodrich and Schmidt, to name only a few, have studied the changes of senescence in beetles, wasps, bees and other insects. In these, deposition of metaplastic substances and pigments, general signs of atrophy or hyperplasia or both were the changes observed.

In regard to Mollusca the investigations on senescence changes are more varied. Burnett Smith observed in Gastropods the following changes amongst others: passing of the shoulder tubercles and spines into a shoulder keel, protrusion of the mantle in the region of the anal siphon, stromboid form of the outer lip of the aperture, tendency towards looseness of the coils, irregularity of growth lines, thickening of the shell, tendency to the formation of smooth and rounded whorls, and discontinuous or recurrent ornamentation. Myonier de Villepoix found that in *Helix aspersa* the gland cells of the mantle disappear, and the cells of the mantle epithelium only are capable of dividing. Szabó, I. and M., studied the changes due to senescence in various forms of Mollusca (*Helix*, *Arion*, *Agriolimax*, *Coretus*, *Planorbis*, *Limnæa* and *Viviperus*) from the points of view of morphology and histology and came to the conclusion that the cause of senile death lies in the liver as in *Agriolimax agrestis* or in the nervous system as in *Limax flavus*, the two species which were investigated in great detail by the authors. One of these two might be primary and the other the secondary cause of death. In the liver it is the increase of connective tissue, and in the nervous system the accumulation of pigment, which causes death.

In addition to the various signs of senescence such as atrophy of cells, accumulation of pigment, increase of connective tissue, loss of weight, etc., Szabó considers the change occurring in the proportion of the nucleus to the cytoplasm as not the least important. But opinion in regard to the nucleo-plasm ratio seems to be divided. One set of observers working on Vertebrates and other Metazoa holds that it is the cytoplasm which increases in proportion to the nucleus during senescence, while another set working on Protozoa holds the opposite view, namely, that the nucleus increases in proportion to the cytoplasm. But considerable doubt has been thrown on this point by the work of Günther Hertwig who showed that such changes as occur in the ratio of nucleo- and cytoplasm were due to the effect of fixatives. Szabó, however, is of the opinion that chemical tests as applied by various investigators (Masing, Schæffer,

Robertson and others) indicate the occurrence of a change in the nucleo-plasm ratio as one of the signs of senescence.

The changes produced by senescence are not uniform in the various species of animals. In one species the signs of senescence are observed in the nervous system, in another in the alimentary system, in a third in the genital system or other organs. In some species all organs show signs of senescence simultaneously as in ants, while in others the genital organs are primarily affected. For every species, therefore, there seems to be a characteristic mode of senescence. Even among individuals of the same species senescent changes may differ as shown by Szabó in *Agriolimax*, by Jennings and Lynch in *Proales*, by Stolz in *Aelosoma* and by Gross in *Hydra*.

Concluding this systematic survey of facts known in regard to the modes of senescence in various groups of animals, Szabó discusses certain general aspects of the subjects of senescence, rejuvenation and potential immortality.

With regard to the influence of germ cells on senescence Szabó is of the opinion that atrophy of these cells cannot be a primary cause of death. Reproductive activity may perhaps weaken an organism, and the state of the germ cells in this weak condition may influence the speed of senescence. In *Agriolimax agrestis*, Szabó, I. and M., observed the scarcity of undifferentiated germ cells (which the authors have designated as the Polimanti cells) in young and egg-laying individuals, and the aggregation of these cells to form a definite tissue (the Polimanti tissue) in non-egg-laying animals with a long span of life. Where this tissue was well developed, genuine atrophy in other cells of the body did not occur. So the conclusion was drawn that the presence of Polimanti cells in some way increases the span of life by maintaining the metabolic rate unchanged and thus delaying atrophy.

Szabó then discusses the results of Child's experiments on senescence and rejuvenation. Child studied the reactions of various animals of all ages such as *Planaria*, Coelenterates, Crustacea and larval amphibians in various media, such as cyanides, ethylalcohol, chloroform, etc., under constant temperature conditions, both in high and low concentrations, and observed how long animals of different ages lived in media of high concentration or acclimatised themselves to media of low concentration. Because of the varying rates of metabolism in animals of different ages, the younger animals were observed to die sooner in concentrated media than the adults, while in media of low concentration they lived longer than the adults. Whether the mode of reproduction is sexual or asexual, the degree of susceptibility depends only on differences in age. Child also observed that in Invertebrates with highly developed power of regeneration, the process of senescence often led to rejuvenation, whether the mode of reproduction was primarily sexual or asexual. From the point of view of senescence and rejuvenation the sexual and asexual modes of reproduction are, therefore, fundamentally similar processes.

The question of potential immortality is discussed by Szabó in detail. If a cell or an individual is potentially immortal, then it does not grow old, or its senescence is balanced by certain processes by which the cell or individual is rejuvenated. In the Metazoa the continuity of the germ-cells is generally accepted as a sign of potential immortality, and from experiments on the tissue culture of Vertebrates it seems likely that cells of tissues of the body other than those of the reproductive organs have a tendency towards potential immortality. In the Protozoa the individuals have a tendency to grow old, but rejuvenation arrests the progress of senescence and maintains the continuity of life. In the lower Metazoa such as worms, Coelenterates, etc., parts of the body are potentially immortal. Immortality seems, therefore, to be a primitive characteristic of unicellular and multicellular lowly-organised animals. It may mean that the animal as a whole or particular tissues do not grow old or that senescence is compensated for occasionally by rejuvenation. For this reason the author suggests that the physiological experiments on potentially immortal organisms should be verified by careful microscopical examinations of the tissues to detect the minute changes due to senescence.

Reviewing the field of literature, death in organisms apart from pathological causes and accidents seems to be the result of cells living together—a heavy price to pay for corporate existence.

H. SRINIVASA RAO.

REVIEWS.

Collected Scientific Papers of Sir William Bate Hardy, F.R.S. Published under the auspices of the Colloid Committee of the Faraday Society. (Cambridge University Press.) 1936. Pp. xi + 922 with 15 Plates. Price 63*sh.* net.

This is a superb volume. It is a worthy memorial of a great scientist whose labours have elucidated some of the abscure problems of the living substance. The work contains fifty-nine contributions, capable of being arranged under three heads: Physiological and histological, problems of the colloid state and the behaviour of liquids and solids at their interfaces. These papers have shed considerable light on the functions of the living cell.

In the preface Professor Eric K. Rideal gives us an insight into the scientific life-work of Hardy and observes as follows:—

> "A number of excellent accounts have been published of the scientific life of Sir William Hardy, but no better epitome has been given us than that expressed by Sir Hugh Anderson, the late master of Hardy's College, Gonville and Caius. 'Hardy once observed a cell divide under a microscope and wondered why.' The wonder excited in Hardy by the observation of cell division set him on the path of these investigations on physico-chemical properties of the proteins and the behaviour of matter in the boundary state."

Numerous appreciations of this aspect of Hardy's work have already appeared, and this collection of his papers must have an immense interest for those engaged in the exploration of the problem "Why and how a cell divides." His earlier work on biological subjects opened a wide and fruitful field of researches on colloids which have familiarised his name to us. The physical problems raised by the study of living matter led Hardy to abandon the current theories of the structure of protoplasm and the prevailing methods of its investigation by fixing and staining the cell. He resorted to study simple colloidal solutions and the results have established the connexion between electric charge and stability, the reversibility of sol-gel transformation and the recognition of globulins as types of colloidal electrolytes. Modern Colloid Science owes a great deal to these investigations and the concept of the colloidal electrotype has added to it a new and illuminating chapter.

In his Guthric Lecture on "Some Problems of Living Matter," Hardy expounded that the available energy of a dead colloid or of an interface is in the main physical in character, while that of living matter is essentially a chemical potential, which gives way in the response to a stimulus, and is restored by an intake of oxygen. "The activities of a living cell appear to be due to a cunning combination of the chemistry of the dead space with the hysteresis of the colloid." Speaking later at the Colloid Symposium at Toronto in 1928, he observed "my thesis soon narrowed itself down to the ungrateful task of displaying the difficulties of the problem, and as a first step, let me state a belief which I have held for thirty years or more. It is that nothing is to be gained by claiming living matter as colloidal." It is true that the mechanical side of the interpretation of life phenomena requires a deeper understanding of molecular physics, but will such a knowledge alone provide us with an exhaustive picture of the manifold implications of what we call life. In the concluding part of his address Hardy has given a picture of his ideal of a Biological College. "It should have three floors, a ground floor of molecular physics, a first floor of biophysics and a top floor for cell mechanics. And of the staff the professor of molecular physics should have no responsibility for biology, the professor of biophysics should be a Mr. Facing-both-ways, responsible to physics and to biology, whilst the professor of cell mechanics should be a biologist pure and simple. That College I should expect to provide the new synthesis of knowledge of which biology stands in need."

Holding such views during all his period of work, he was led to investigate new problems regarding the static friction between solid faces of films of lubricant, when they are sufficiently near to each other to influence its physical properties. His researches on "boundary conditions" led him to establish facts far beyond their original scope, and provided problems in the properties of films on solid surfaces and

those of liquid films on liquids, for further study and investigation.

In his Abraham Flexner Lecture (1931) Hardy expresses his mature ideas regarding what he calls the greatest of the many improbabilities of living matter, and the momentous inference he draws from it. By virtue of its asymmetric powers of producing optically active compounds from symmetrical substances, living matter "seems able to evade an enormous mathematical improbability", *viz.*, in the first photosynthesis of carbon dioxide and water to formaldehyde, the chloroplast contrives to catch and hold three quanta at once, and in this it is unique, for no known endothermic photochemical reaction involves more than one quantum. The dynamical systems in the living cell are produced by the capacity of the amino acids interacting with its molecular asymmetry. Asymmetry of living substance is specific and constant, but the barrier separating the asymmetric and symmetric world is not absolute as is proved by the synthetic products of the laboratory. To the question "how was the first asymmetric molecule created", Hardy seems inclined to think that "the beginning of life was an unique event at any rate in world history. There must have been a definite creative period whose duration does not concern us and whose character in three dimensional chemistry is a mathematical improbability." That there is something beyond physics and chemistry is envisaged by the cautious adoption by Hardy of the hypothesis of a special vital force and "the search for it is as likely to lead to our goal as any other." He would even go further and say "that the physical and chemical improbabilities of living matter are so great as to make an hypothesis of special creations more restful and almost as valid as that of continuous evolution." Hardy declares that he is not shocked by vitalism, but only he is afraid of it as a dangerous flag to fight under; it is, however, refreshing to read this pregnant sentence,—"Is there any guess which comes within whooping distance of the shifts and tricks by which the primordial slime clothed itself in diffraction gratings to give the birds the colour they need in a tropical forest."

Within the limited space at the disposal of the reviewer, it is almost impossible to attempt anything more than bare notice of the work of a great scientist who has browsed far and wide in new and fresh pastures. His work is distinguished by a spacious dignity and a classic breadth of outlook, rare in these days of hurry and specialisation. Every scientist interested in the problems of biology and chemistry is deeply indebted to Professor Eric Rideal for his task of publishing this volume under the auspices of the Colloid Committee of the Farady Society assisted by the Dominion Governments of Australia, South Africa and New Zealand, the Royal Society and the Chemical, Biochemical and Physiological and Faraday Societies, in collaboration with the Master of Fellows of Gonville and Caius College.

Theoretical Astrophysics. By S. Rosseland. (Clarendon Press, Oxford.) 1936. Pp. 355. Price 25*sh*.

The appearance of a text-book on Astrophysics by so eminent an authority as Prof. Rosseland will be welcomed by all students of the subject. To those who are acquainted with his excellent little German book of 1930 *Astrophysik auf atomtheoretischer Grundlage* the present book and the planned second volume will serve as the fulfilment of the hopes cherished by them of the appearance of a regular text-book on Theoretical Astrophysics. In the older book, the order of topics treated was stellar interiors, stellar hydrodynamics, stellar atmospheres and finally gaseous nebulæ. In the present work, Professor Rosseland has partially reversed the order by treating in the first volume the subjects of stellar atmospheres and the outlying portions which he calls envelopes while reserving for the second volume the study of stellar interiors. There is no doubt that this is the most logical method of development from the learner's point of view. Another innovation in the present volume is the foundation of atomic physics that it is laid out in the first eight chapters so that the superstructure may be well and truly built. The topics dealt with in these eight chapters have been carefully and deliberately chosen with an eye on future application in astrophysical problems. While this has its undoubted advantages, it has also resulted in a rather condensed treatment and makes difficult reading in certain places, specially in the second chapter devoted to statistical mechanics. The idea of devoting a separate chapter to Dirac's theory of radiation is an excellent one and for a student of Astrophysics no better

account of it can be given than what is contained in the eighth chapter.

Chapters nine to eighteen are devoted to the essential developments relating to the lower atmospheric strata wherein thermodynamic equilibrium holds good. The remaining chapters are devoted to the highest atmospheric layers.

It may be said at once that this work is not meant to be a comprehensive treatise but a programme which the author has chalked out for introducing a beginner into the subject. Stress is therefore laid more on the underlying principles than on the actual details of several investigations and this makes the book all the more valuable for purposes of study.

Not the least interesting part of the book is the beautiful introduction of nine pages. It supplies the necessary historical background and no one who has read it will fail to see at once the great enthusiasm of the author for his subject. What is most gratifying to Indian readers is the very handsome tribute paid to the fundamental contributions of Prof. Megh Nad Saha to stellar spectroscopy. (We might incidentally notice here the curious misprint on p. xvi "Megd" instead of "Megh".)

Prof. Rosseland has rendered a great service to students of Astrophysics in bringing together in a collected form the latest developments of the several branches of Theoretical Astrophysics. We keenly await the appearance of the second volume.

B. S. M.

Short Wave Wireless Communication. By Ladner and Stoner. (Chapman and Hall, London.) 1936. 3rd Edition, revised and enlarged. Pp. 453. Price 21*sh*.

Since the publication of the first edition in 1932 this book has become so well known that a general review of the work as a whole is superfluous. The third edition now issued is a revised and somewhat amplified version of the second edition which appeared in 1934.

The chapter on Aerials is considerably enlarged and includes revised paragraphs on the effect of earth conductivity and a brief account of high frequency measurements of earth conductivity and dielectric coefficient.

A new chapter is added on commercial wireless telephone circuits, the practice in this branch of radio engineering being considered to be now sufficiently stabilised to warrant a text-book account.

New matter includes a discussion of the method of frequency modulation employed as an antifading device in telegraphy; and a description of appropriate circuits for putting the method into effect is appended.

In the four years since its first appearance the book has become indispensable to students of radio-communication. That this is widely recognised is attested by the fact that this third edition represents the sixth printing in this short period.

The printing and get-up of the volume are similar to those of the second edition and are excellent.

E. P. M.

Electrical Handicraftsman and Experimenter's Manual. By Langman and Moore. (Technical Press, London.) 1936. Pp. 192. Price 7*s*. 6*d*.

I consider that this book is not suitable for serious review in *Current Science*.

This is a book not easy to classify. It is claimed to be a "manual," a *vade-mecum* for electrical handicraftsmen, students, experimenters and inventors. From this one might expect a compendium of useful information arranged for convenient and constant reference, for those classes of readers.

Actually the book is very discursive and built, apparently, to no definite plan. It contains a good deal of information, some of it more curious than useful, on mechanisms and devices. It is conceivable that some of these might be turned to account by a worker faced with a practical problem. This information is conveyed in what is really a series of notes, illustrated by some excellently drawn diagrams, which may be regarded as the book's most valuable feature. A good deal of space seems to be wasted over devices of long obsolete types (such as, for instance, soleniod motors); and on models designed to illustrate simple principles which appear to be inappropriate to a manual for handicraftsmen, experimenters and inventors, or even for any but the most elementary of students.

In some instances these models hardly achieve their ostensible purpose. For example, on page 174 we find an account of an "electromechanical contrivance for correlating principles involved in mercurial and aneroid barometers." This turns out to be an arrangement (or rather two arrangements) for relating rectilinear motion to circular motion and so comparing a straight with a circular scale by means somewhat reminiscent of the school of practice associated with the name of Mr. Heath Robinson.

The book is well turned out as regards printing, illustrations, paper and binding.

E. P. M.

INDUSTRIAL OUTLOOK.

Problems of the Leather Industry in India.

By Rai Bahadur B. M. Das, M.A. (Cal.), M.Sc. (Leeds).
(*Superintendent, Bengal Tanning Institute.*)

LEATHER is now an important item of trade. It has multifarious uses. A large amount of it is consumed in the equipment of the Army and the Police Forces of the country; its consumption in making shoes, travelling requisites and various kinds of leather articles is very large. A considerable quantity is required in mills, factories, workshops and railways for various mechanical purposes. With the advancement of modern civilisation the scope of its utility is continuing to widen and its importance and indispensability in many of the activities of human life of the present-day world has been firmly established.

Hides and skins, primarily of the domestic animals, *e.g.*, buffalo, cow and oxen, goat and sheep, etc., which are bred and reared in every country for farming and food are the chief raw materials for making leather. Their supply is fairly large and regular. The ever-increasing demand for leather has, however, made it necessary to tap other resources and now skins of wild and aquatic animals are appreciably supplementing the hides and skins of domestic herds to satisfy this demand.

Hides and skins kept raw as obtained from the backs of animals, rot and decay in a short time. Different treatments, physical and chemical, are needed to stop putrefaction and to convert these putrescible animal products to leather suitable for human use. The processes are called "curing" and "tanning" respectively. The methods that are in vogue to-day, have evolved to their present stage through thousands of years' practice and experience. There must have been innumerable trials and experiments. The failures have been forgotten. Only those which yielded satisfactory results have survived and have been handed down to us.

No human art or occupation can indeed claim such antiquity as the art of leather-making. It is much older than agriculture, for it is now universally recognised that long before men learnt to till the soil, they used to live by hunting. And it must have occurred to the primitive hunters to use the furs of the animals they bagged for clothing as a protection against cold and rain. It must have also been noticed by them that kept as such the skins did not remain sound. Drying in the sun would no doubt help in their preservation but it made the skins too hard for use. Hence they must have tried to soften the skins while drying by applying the fat of the very animals they bagged whose emolient action they must have previously observed on their own skins. Thus originated the early method of dressing skins with the wild tribes in prehistoric times, which may be called the precursor of modern tanning. This method of tanning with animal fat in a modified form is practised even to-day, and is known as oil tannage by which the well-known chamois leather is made even now.

Use of vegetable matters such as barks, fruits and leaves of trees in tanning, is of much later origin, and that of mineral substances such as alum and salt belongs to a still later date, while the application of chrome salts for tanning is quite a modern invention.

Tanning attained considerable development in ancient Egypt. An Egyptian granite carving showing leather dressers at work, believed to be 4,000 years old, is displayed in the Berlin Museum. Old records show that tanning was practised in ancient times in China and India.

In Europe tanning was understood by the ancient Greeks and Romans but the development was slow and the art remained practically stagnant till the 19th century A.D. From the early times till the last decade of the 19th century the principal method used was that of tanning with vegetable matters. Methods were all rule of thumb, the principles underlying were not well understood and much secrecy was observed by successful manufacturers. The art was in short empirical.

Modern science, which has resuscitated so many arts from empiricism, was not long unmindful of the art of leather-making; chemical, physical and bacteriological sciences soon explained many unseen phenomena of tanning and clearly exposed the principles underlying it. Mechanical Engineering replaced many slow, though in some cases skilled manual labour, by many time- and labour-saving machinery. Empirical rules, rule of thumb ways, and the so-called trade secrets were swept away before the

flood of scientific knowledge. The modern art of tanning is now almost an exact science and leather manufacture a chemical industry.

The leather industry has immense possibilities in India. In respect of resources of raw materials, *e.g.*, raw hides and skins, India's position is very high among the different countries of the world. Out of the 600 million cows and kips of the world India possesses about 160 million. Of the estimated 47 million heads of world's buffaloes, India has about 34 million ; of the 203 million goats, India claims 53 million and of the total 575 million sheep and lambs in the world the estimated share of India counts 41 million. The annual supply of hides and skins from this huge live-stock has been estimated by Arnold as under :—

Cattle hides	..	20	million pieces.
Buffalo hides	..	3.5	do
Goat skins	..	22.0	do
Sheep skins	..	11.5	do

Besides, the jungles in India are proverbially full of snakes and lizards and there is no dearth of crocodiles in her waters. The skins of these wild and aquatic animals have of late been turned into normal trade commodities.

All these available hides and skins are suitable for the manufacture of nearly all varieties of leather that India needs at present. Her cattle hides produce a shoe upper leather of medium and cheap grades suitable for the shoes of middle and poor classes of her population, while her goat skins, which in quality are among the best in the world, and produce the finest kind of upper leather can be used in the making of shoes for her rich and classy people and the ladies. The sheep skins produce the lining leather and the buffalo hides supply the leather for soles and insoles of boots and shoes and for multifarious industrial purposes. The cattle hides also produce leather for trunks, suit cases, bags, straps, belts, etc., and the sheep, goat and reptile skins produce excellent leather for fancy and luxury articles. Upholstery leather can be made from cattle hides, goat and sheep skins.

India is well provided with many vegetable tanning materials. Three of them at least have a very wide use. These are babul bark (*Acacia arabica*) of Northern India, avaram or tarwar bark (*Cassia auriculata*) of Southern India and myrobalans (*Terminalia chebula*). These materials have been in use in the Indian Tanning Industry for quite a long time, and have been found to produce excellent tannages. As a matter of fact tarwar bark is one of the best tanning materials known, in respect of excellence of colour it produces on leather and the speed with which tanning is effected. Its supply, however, is not quite adequate. The supply of babul bark, on the other hand, is still ample, steady and reliable. Babul produces leather almost similar to the British Oak tanned variety. India not only produces all the myrobalans she requires but exports a considerable quantity to foreign countries.

Notwithstanding the various advantages mentioned above, the leather industry in India has not developed to that extent as one should expect. The causes are threefold (i) social, (ii) economic and (iii) technical. An attempt has been made to explain the difficulties under these heads in the following paragraphs in order.

Social.—To the Hindus who constitute the bulk of the Indian population, raw hides and skins are abhorrent. The very sight of a slaughtered cow gives a rude shock to their religious sentiments and even the touch of those who deal in raw hides and skins, is considered by many as pollution. Under the circumstances, the raw materials were left from time immemorial in the hands of an illiterate depressed class, called "chamars". Neither the trade in raw hides and skins nor the art of leather making could, therefore, develop until the attention of foreigners was drawn to them. If we have been indifferent from our extreme religiosity and snobbish sentiments, others were alert and saw in the Indian hides and skins vast potentialities.

Formerly in India hides and skins were the property of the village chamar who flayed the dead animal and tanned the hide or skin to supply local needs for leather. But as these needs were limited, much of the available raw materials were left uncared for and wasted.

Demand of Indian hides and skins from countries abroad created an export trade which developed steadily. This appreciated their value considerably. Records show that in 1846 the average value of an Indian cow hide was only 7as. 5p. and of a skin 3as. 2p. while in 1912–13 the average value of a cow hide rose to Rs. 6 and that of the skin to Rs. 1–9–6. This rise in the price gave an impetus to the better care and collection of hides and skins and the value of their export trade increased by leaps and bounds. In 1912–13, that is to say, just before the World War it rose to about 12 crores of rupees,

The post-War trade depression which depreciated commodity prices reduced the values of Indian hides and skins also. At present the average value of an Indian cow hide is about Rs. 3 and of a goat skin Re. 1.

Economic.—India is regarded as a surplus country in respect of hides and skins. So is she in her present condition, but if the standard of living of her people is raised, all the hides and skins available in the country will not be sufficient to provide the 320 million Indians with even one pair of shoes per head per annum. Besides shoes, leather is also required for many industrial purposes. This must also be supplied so that India may pursue her industries.

The Indians have got a very small purchasing power, and therefore, they have to forego not only many amenities but also many necessities of modern life. Shoes are not only a part of civilised dress but they are also necessary on hygienic grounds. In India only a few can afford to buy shoes and millions go about bare-footed as they have got no money to buy footwear. The poverty of the Indian people is a source of great weakness not only for the Indian Leather Industry but also for many other industries. Unless the home market is strong, industries have very little support to rest on. For, to sell finished products in foreign markets one has to surmount several barriers, and the tariff walls in many countries are almost insurmountable.

The foreign demand for Indian hides and skins exerts considerable influence on the local tanning industry. When this demand is large Indian tanners cannot buy their requirements of hides and skins at prices they can afford to pay. At such times the bulk of the hides and skins is exported. The local tanners get only the portion left over after the exporters have been satisfied.

Before the War the Germans were the keenest buyers of Indian cattle and buffalo hides and the Americans of goat skins. The export of these materials was so heavy that Indian tanners could hardly get sufficient raw stocks for local tanning.

The adverse effects of unfettered export of raw hides and skins on the local tanning industry was first noticed during the last Great War. Large quantities of leather were required for war purposes which the Indian tanning industry was called upon to supply. The importance of the conservation of raw hides for tanning and development of the tanning industry in India and within

Export duty on raw hides and skins.—With the above objects in view the Government of India imposed an export duty of 15 per cent. on the export of raw hides and skins with the provision for a rebate of 10 per cent. in case the exported hides and skins were tanned within the British Empire. The 15 per cent. duty, however, had a very short life. The Fiscal Commission of 1921–22 condemned the export duty on hides but retained a small duty on skins. The Government of India, however, reduced the 15 per cent. preferential duty to one of a flat duty of 5 per cent. for all countries in the year 1923. There was good deal of controversy over the hide export duty. It was extremely unpopular with the raw hide exporters, but local tanners found in it a brake on the uncontrolled export of a material on which their living depended. As a result of persistent agitation the export duty on hides and skins has been abolished.

For a long time the raw hide export trade made tanning in India a highly speculative business. Local tanners were not sure what the prices of their raw materials would be, say, after a week or a fortnight. In sympathy with the foreign demand the prices might soar up or climb down. It was difficult for them to buy hides in large quantities or to effect large sales of leather in advance. There was a limit upto which they could pay for hides and for tanners who sold their products in the internal markets, this limit was imposed by the purchasing power of their customers in India. If the limit was exceeded the customers refused to respond. The exporters on the other hand sold in markets where the purchasing power of the people was greater than it was in India and therefore could afford to pay higher prices than Indian tanners.

For several years right upto the War it was the exporter who won in this competition, but the War changed the economic conditions of the countries which used to buy Indian hides and skins. Their purchasing power dwindled. Europe and America have not been buying quite as many hides and skins during post-War years as they used to do before the War. The result has been that more hides and skins are now available for local tanning at prices which the Indian consumers can afford to pay. The Indian Tanning Industry thus got the chance to grow and develop, and it has not let the opportunity slip.

The present tanning industry in India falls into three sections, the crude country tanning, the half tanning and finished

Crude-Tanning.—Crude-tanning is done by innumerable chamars in villages throughout India and the crude leather is used for making the various types of indigenous footwear, *e.g.*, Nagra and Munda shoes, slippers, chappals, etc., which are mostly worn by the poor rural population. Considerable quantities of this crude leather is also used for cheap harness and saddlery and water-bags (Mashaks). The out-turn of this crude leather is quite considerable but accurate statistics is not available. This type of tanning badly requires improvement but it is a real problem how to effect it. The solution lies in the introduction of modern improved processes into India's rural tanning but the poverty and illiteracy of the village tanners make this introduction extremely difficult. It is necessary to bring both capital and education to bear upon this section of Indian tanning. Attempts in this direction are being made by the Departments of Industries of some of the Provincial Governments. In Bengal, two peripatetic tanning demonstration parties are maintained by the Government under the Department of Industries. The parties are attached to the Bengal Tanning Institute. They give demonstrations of modern tanning methods in villages over one to two months at a place. Village chamars as well as educated youngmen of the higher castes are admitted as students in these classes. After training, the youngmen are encouraged to start tanning on a small scale using modern methods in the villages and small towns. In this way a number of educated middle class youths have been trained up, some of whom are engaged in tanning in rural areas. Chamars have also been taught modern methods of work and some of them are using these methods in preference to the crude processes handed down to them by their forefathers.

Governments of the Punjab and Bombay have also started such demonstration parties with the object of improving crude tanning in rural areas.

Half Tanning.—The half tanning industry is the largest section of the Indian Tanning Industry. It is carried out in Madras and Bombay and its annual production is worth about five crores of rupees. The half-tanned leather is exported from India. Bulk of it goes to England and smaller proportions to such other countries as America and Japan, etc. Only the very [illegible] selections, *viz.*, the rejections and rejections. are sold in India.

The location of the half tanning industry in Madras and Bombay is due to the occurrence in these provinces of avaram bark which is very suitable for making half-tanned leather. For a long time this bark was exclusively used for the production of half-tanned leather but since the War it has been partly replaced by wattle bark imported to Madras from South Africa. At present cow and buffalo hides are tanned with wattle while goat and sheep skins with avaram bark.

The process of half tanning is entirely indigenous and the method is rule of thumb and more or less crude. The product, however, is satisfactory to those who buy it. Improvement in this branch is, therefore, not so urgent in regard to quality but to methods of work which appear to be wasteful. Scientific control is expected to reduce the wastage and cost of production by saving time, labour and materials. Pointed attention of tanners engaged in this important branch of Indian leather industry is drawn to the advantage of harnessing science to service. Period of liming which according to present practice varies from 7 to 20 days can be shortened considerably by sharpening lime with sulphide depilatories. The present tedious practice of removing lime by repeated tramplings and beatings in several changes of water can with advantage be replaced by quicker methods of deliming with weak acids and enzyme bates. According to present practice about $\frac{1}{3}$ of the available tannin in the avaram bark and $\frac{1}{4}$ in wattle are lost in the spent tan through inadequate extraction which can be prevented by adoption of recognised methods of extraction of tanstuffs. Good deal of stains which appear on the half-tanned leather in the present method of work can be avoided by substituting the contact process of tanning by the liquor method. Initial attempts of the introduction of these reforms to the time old process may encounter difficulties but they are sure to yield to sustain the efforts as has been the case in Western countries where tanning has been elevated to the position of a scientific industry as opposed to an empirical craft. It is high time that the half tanning which had better be called crust tanning were modernised and freed from antiquated and wasteful methods of work.

Finished Leather.—The manufacture of finished leather has been making rapid strides in India. This divides itself in two

broad classes: the bark tanned and chrome tanned. The former consists of sole, harness and saddlery, ammunition boot upper, suitcase and bag, morocco, printed goat, coloured sheep, coloured calf, suede and reptile leathers. These are mostly made for internal consumption, a proportion of the sole leather only being exported.

It is in the manufacture of chrome-tanned shoe upper leather that the bigger tanneries in India are engaged. These leathers are black box sides and calf, brown or willow sides and calf, and black and brown glace kid. Black and willow sides are manufactured from cow hides, box and willow calf from calf skins, and glace kid from goat skins. Successful manufacture of these leathers requires good deal of technical knowledge, scientific control and a number of machines. The tanneries in India which are engaged in their production are more or less adequately equipped with the required machinery and have in their employ trained experts, technical assistants and machine operatives. Almost all the experts are either foreigners or Indians who have had training in the manufacture of leather and in leather chemistry in foreign countries. The technical assistants are mostly trained students of the Bengal Tanning Institute and Leather Trades Institute of Madras. Some have been trained up in tanneries starting as apprentices. Machine operatives are all Indians who have been trained in the tanneries.

Indian box sides and box calf have been improved in quality to a great extent through the efforts of the commercial chrome tanneries and by the researches and investigations of the trade institutes like the Bengal Tanning Institute. The Indian products are now being sold in overseas markets in competition with foreign leathers. The Ottawa Agreement gave a great impetus to the export of this leather to the United Kingdom. About 26 lakhs of rupees worth of box sides and box calf was exported from India in 1935. Before the Ottawa Agreement this export was practically nil. The Agreement, therefore, helped the Indian chrome leather industry to a very great extent.

A few tanneries in India are also manufacturing glace kid from Indian goat skins. The product is sold in India and a large proportion is also exported. The quality of the Indian glace kid has been greatly improved and no difficulty is being experienced in marketing it in foreign countries.

Among other varieties of chrome leather manufactured in India may be mentioned chrome sole leather, picking band and lace leather. Picking bands are used in textile mills. Large quantities of these bands are still imported. The annual value of the import of picking band is about eight lakhs of rupees. This import shows that there is a great deal of scope for the manufacture of picking bands in India.

Chrome laces are used for stitching machine belts and are required in all types of factories using belt drives for running machines. Tuggers, taper bands, leather springs for looms are also made from locally manufactured chrome leather.

Apart from its use in sandals and chappals chrome sole is also utilised in making ginning washers for which there is a large demand.

Fancy Leather.—Manufacture of finished light leathers (fancy leather) has not yet been taken up on any large extent in this country although a great bulk of the light leather is manufactured in Great Britain, Germany and other countries from the tanned goat and sheep skins exported from Madras and Bombay. Roller skins are an important variety of light leather required for industrial use in textile mills. These are all imported. The annual value of the import of roller skin is about seven lakhs of rupees.

In spite of what is being done the finished leather industry has not developed in India to the extent her raw materials and resources justify. The reason for this is the very small consumption of the finished leather, in this country. The purchasing power of the Indian masses is proverbially poor. They can only afford to buy cheap and crude leather and yet cheaper leather substitutes.

The way to foster the finished leather industry in India is to make suitable fiscal arrangements with those countries which now import Indian raw hides and skins and rough tanned leather. These countries should be made to take at least a quota of the Indian finished leathers without imposing prohibitive duties on them as they do now in consideration of the help that India renders them by supplying the raw materials on which they so largely depend for their leather industries. The Ottawa Agreement has been a great eye opener in this direction. Due to the preference given to the Indian chrome leather in the United Kingdom a phenomenal development of the chrome leather industry has resulted during the operation of the Agreement. Similar developments are possible in other branches of the industry under equally favourable fiscal arrangements in their regard.

International Chemical Engineering Congress of the World Power Conference.

THE above Congress, the first of its kind, was held in London at the Central Hall, Westminster, from 22nd June to 27th June 1936 and was attended by delegates and members—representing forty nations—from all over the world. There were nearly 800 members of which nearly 450 were from Great Britain, 150 from the United States of America and a good number from Japan and Germany. On account of the Italo-Abyssinian War and its repercussions on the public opinion abroad, there was only one member from Italy.

The choice of the venue for the Conference was a very happy one, not only on account of the large space available at the Central Hall but also on account of its proximity to such historical places as the Westminster Abbey, the Houses of Parliament, Whitehall Offices and not far from the Buckingham Palace.

The meeting of the Chemical Engineering Congress coincided with the visit of the American Institute of Chemical Engineers to the Institution of Chemical Engineers of Great Britain. His stature and official position made Dr. Ittner, the President of the American Institute, conspicuous at every function.

Of the many distinguished visitors from the United States, particular mention may be made of Dr. L. H. Baekeland, of the Baekeland Corporation, who needs no introduction on account of his bakelite fame. He is a very kindly unostentatious man with charming personality and easy manners, young in spirit, though older in years and always ready with amusing anecdotes. Even his visiting card, which is too small to hold all the honours and distinctions conferred on him, thus making it necessary to accompany it with a long separate supplement, is not without its humour. "Dr. L. H. Baekeland, "Snug Rock", Harmony Park, Tonkers-on-Hudson."

Another visitor who attracted much attention was Professor Ushkevitch, Director of a Technical Institute at Moscow, U.S.S.R.

As is to be expected at such an international gathering, one could not help hearing a large number of languages in the lounge and elsewhere.

Let it be stated at the very outset that the Congress was a great scientific and social success and the credit goes to the organisers—many of whom were drawn from the Institution of Chemical Engineers—for every detail that had been carefully thought out and worked.

The idea of holding such a congress originated with the late Sir Frederick Nathan and every one regretted that he was not spared by Providence to see its fruition.

The Congress was opened by his Royal Highness the Duke of Kent on the afternoon of Monday, the 22nd June, with Lord Leverhulme, the President of the Congress, in the chair and with the heads of the delegations and representatives on the platform.

His Royal Highness said that it was now twelve years when his brother, the King, then Prince of Wales, opened the First World Power Conference at Wembley. Many of the high hopes of which he spoke then, had since been realized and the World Power Conference by means of meetings which it held in various parts of the world had proved itself effective in securing international co-operation between engineers, technicians and administrators. Next September there was to be a Third World Power Conference in Washington at the invitation of the United States Government.

Extending a warm welcome to all the overseas delegates and members, His Royal Highness said proud as each country was of her great scientists and inventors, their work once done became international and contributed to the welfare and happiness of every race. This century had seen the development of science more rapid, more wide and more fundamental than in any previous age. No profession had been more ready or more skilful than their own in using all the resources science could offer. With the opening of that first international conference it came of age.

Chemical Engineering had made such progress that it has entirely altered the meaning of the word "artificial". At one time artificial implied some measure of inferiority but to-day there was no such stigma attached to its modern equivalent 'synthetic'. Their success had been achieved by the union of the engineer and the chemist. He had always been amazed at the skill with which the engineer had enabled chemical reactions to be carried out on a gigantic scale, with certainty of control and under conditions for the workers which contrasted so favourably with those of the past. It was an achievement of which they, as chemical engineers, might well feel proud.

He wished them success in their deliberations and he hoped that they would carry away happy recollections of those few days spent in London and that the effects of the meeting would extend far beyond the technical confines of their immediate discussions.

After thanking His Royal Highness, the Duke of Kent, for opening the Congress, Lord Leverhulme proceeded to deliver his presidential address.

Nearly 127 papers were presented to the Congress and only a few of them were discussed in the meetings during the next four days.

For the sake of convenience, the above papers were classified into the following thirteen sections covering an astonishingly wide range of subjects: (*a*) Ferrous Metals in Chemical Plant Construction. (*b*) Refractories, Rubber, Plastics and other Materials in Chemical Plant Construction. (*c*) Separation by Washing, Filtering, Distillation, etc. (*d*) Size Reduction, Grading and Mixing, Electrolysis and Electrical Applications. (*e*) Destructive Distillation. (*f*) Treatment and Disposal of Effluents and Waste Materials; Lubrication. (*g*) High Pressure Reactions and High Vacua. (*h*) Heat Exchange. (*i*) Education and Training. (*j*) Statistics; Administration; Safety and Welfare. (*k*) Trend of Development. (*l*) General Aspects.

There was a General Reporter to each section and he presented very ably a concise and very lucid account of the important or striking features of the papers in his section and added his own comments on them. The meeting of each section lasted only an hour and a quarter so that there was not much time available for discussing the papers.

It would not be fair to single out any paper or set of papers for special mention. Reference may, however, be made to a paper entitled "Underground Gasification of Coals" by Chekin, Semenoff and Galinker from U. S. S. R. on account of its novelty.

The authors state that the great cost of the operations associated with the mining of coal can be largely eliminated by gasifying coal underground, the gas being used for generating electric power or transmitted through pipe lines.

The idea of underground gasification was mentioned by Mendeléef in 1888. In 1931, the Russian Government granted a subsidy to their technical men to carry out large-scale experiments to attain the goal.

As a result of investigations, two new schemes have been adopted for the basis of further work. One instance is given of the Gorlovka Mine which has been operated since 1935 on blows supplied periodically. The gas produced during the air blow is named 'power gas' and is suitable for combustion and heating supply. At present the mine yields 25,000–30,000 cubic metres of power raising gas per 24 hours, and 12,000–15,000 cu.m. of gas for chemical use. The length of each period with and without air-blow varied from 4 to 6 hours. This method is stated to be simple and inexpensive. The authors conclude by stating that underground gasification of coal offers a wide field of action for investigators, engineers and designers.

The closing meeting of the Congress was held on the morning of Saturday, the 27th June, with Sir Harold Hartley, the President of the Third World Power Conference, in the chair. The chairman of the Technical and Organising Committees spoke and were followed by the valedictory speeches from some of the overseas delegates. Lord Leverhulme thanked the Duke of Kent for His Royal Highness's patronage and His Majesty's Government for the encouraging and admirable support which they had given to the Congress.

Finally, Sir Harold Hartley mentioned in his closing speech that the German delegation had extended its invitation to the Congress to hold its second meeting in Berlin in 1940.

In addition to the above meetings, visits were organised on two afternoons to Chemical Engineering Laboratories, Fuel Research Station, Chemical Laboratories at Teddington and to some factories in and around London. These were well patronised and the management everywhere spared no efforts to make the visits very pleasant, enjoyable and instructive for the membrse.

The social side of the Congress was very well attended to. There were several official luncheons, dinners and a banquet at the Grosvenor House. At the banquet, Lord Rutherford, in proposing "The Chemical Engineering Congress" urged that pure science should be given a free hand in the future in order that industry might thrive. Sir David Milne Watson, Chairman of the Organising Committee, who responded, said that all nations had a common bond in science and the hope of the future world peace was to be found in the *rapprochement* of the nations in scientific matters. In proposing "Our visitors from Overseas," Mr. Macdonald, Lord President of the Council, said that chemical engineers were not only building the economic foundations of a new generation but were uniting, in a way that had never been done before, pure science with industry. They were raising industry to a new intellectual and spiritual level and were giving it a new technique.

During the Congress Week but entirely separate from its activities was held the Fourteenth Dinner of the Institution of Chemical Engineers at which members of the American Institute of Chemical Engineers and the heads of overseas delegations were entertained, Captain Evan Wallace, Secretary of the Department of Overseas Trade, being the principal guest. There were the usual after-dinner speeches by the principal guest, Dr. Levinstein, the President, and many others present.

Three receptions were held in connection with the Congress: the first at the Dorchester Hotel where Lord Leverhulme, the President of the Congress, received the guests; the second was held at the Lancaster House by His Majesty's Government, Mr. Ramsay Macdonald and his daughter, Miss Ishbel, receiving the guests; and the third was held at the Imperial Chemical Industries House in Milbank where Sir Harry and Lady McGowan received the guests. This last reception was a very grand one. The ball-room, the Directors' rooms and other offices were all open to visitors for inspection and there were industrial films being shown all the time. Some of the Company's products were displayed in the Exhibition Room in a very attractive style. Refreshments and drinks were provided on a very sumptuous scale and every one seemed to enjoy this reception most.

This Congress enabled its members to renew old friendships and to make new acquaintances. It gave them an excellent opportunity to discuss their problems with one another and to invite valuable comments on their views and methods from their colleagues working in the same field.

British Chemical Plant Exhibition.

THIS Exhibition, held by the British Chemical Plant Manufacturers' Association concurrently and at the same place as the Chemical Engineering Congress, was opened by the Rt. Hon. Mr. Ramsay Macdonald on Monday, the 22nd June, at the Central Hall, Westminster.

Mr. Monnypenny, the Chairman of the Association, said that, that Exhibition, the third of its kind—the other two having been held in 1926 and in 1931—showed what a great progress the British manufactures of chemical plant had made in this direction in the post-War years. In order to qualify as British, at least 75% of the cost of production—including material and labour—of the plant must be British or of Empire origin. He laid emphasis on the closer co-operation between the chemical manufacturer and the chemical plant manufacturer and said that, so far as he knew, the confidence of the former had not in a single case been betrayed by the latter.

Mr. Ramsay Macdonald, in declaring the Exhibition open, said that he was greatly impressed by the achievements of British chemical engineering one of the notable examples of which he saw in the plant for the conversion of coal into oil at Billingham. The aim of the Department of Scientific and Industrial Research with which he is connected *ex officio* as Lord President of the Council is to promote co-operation and interchange of ideas between the chemist, the physicist and the engineer.

Later, an inaugural lunch was held at the Hotel Victoria and was attended by a very large number of members of the Congress and guests. In proposing the toast of the British Chemical Plant Manufacturers' Association, Sir David Milne Watson, who is himself connected with a large chemical industry, *viz.*, the gas industry, laid emphasis on the need and value of making one's products known to the users by what was at one time known as propaganda but now goes under the name of "communication". Mr. Ramsay Macdonald in his speech expressed the hope that there would be closer co-operation between Great Britain, Germany and the United States in this field.

The Exhibition illustrated the wide range of apparatus and plant that is now available in Great Britain, not only for the chemical industries but also for the numerous others which utilise similar equipment. On its stands could be seen and examined the latest advances in chemical plant together with the host of appliances and equipment that are required to meet the demands of modern industry. In addition to the apparatus required for processes such as evaporation, distillation, drying, feeding, screening, sifting, etc., plants designed for filtering, pumping, separating, clarifying, emulsifying, etc., were also on view.

The stainless steels—called 'special' steels on account of their resistance to heat, rust, acids—were shown by their respective makers. The plant manufacturers have made them 'general' by their utilisation in the fabrication of equipment where contamination is undesirable. Of note amongst the corrosion resistant plant which included aluminium, etc., mention may be made of glass-lined equipment—which is, so to speak, the works counterpart of laboratory glassware—vitreous enamelled receptacles and the new white stone ware.

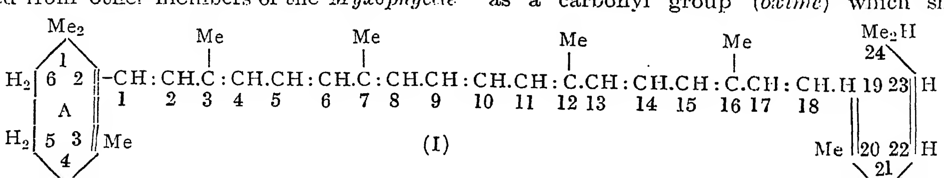
Instruments for the indication, control and recording of temperatures, pressures, humidities, hydrogen ion concentration, meters for various uses, pyrometers and many other essential means for the control of industrial operations were displayed in quantity.

The Industrial Research Exhibit—a very large stand organised by the Department of Scientific and Industrial Research—was very interesting and instructive. It was designed to show how this department aids British industry by applying the results of scientific research to its problems—a subject to which no progressive country could remain indifferent.

The exhibits were displayed in a very attractive manner and demonstrated the high quality of British workmanship. At all hours of the day, the stands were always crowded with visitors and their inquiries were promptly and courteously attended to.

RESEARCH NOTES.

Carotenoid Pigments of Algae.—The Structure of Myxoxanthin.—The first isolation of an individual polyene pigment from the blue-green algæ (Myxophyceæ) was recorded by Heilbron, Lythgoe and Phipers, when *myxoxanthin* was obtained from *Rivularia nitida* (*Nature*, 1935, **136,** 989). This pigment was subsequently obtained from other members of the *Myxophyceæ* and appears to be characteristic of this class just as fucoxanthin is typical of the Phæophyceæ. Heilbron and Lythgoe (*J. C. S.*, 1936, 1376) have found a convenient source of myxoxanthin in *Oscillatoria rubrescens* and have succeeded in determining its structrue (1). It has the formula $C_{40}H_{54}O$, the oxygen atom being present as a carbonyl group (*oxime*) which shows no



(I)

tendency to enolise. Quantitative microhydrogenation in decalin-acetic acid of the pigment and its oxime indicates the presence of 12 ethenoid linkages. It follows that myxoxanthin is monocyclic and is to be classed with γ-carotene and rubixanthin. Like γ-carotene, it contains an unsubstituted β-ionone ring since biological experiments with vitamin-A-starved rats show that it possesses growth-promoting properties. That the carbonyl group is conjugated with the polyene chain is shown both by the colour difference between solutions of the same concentration in light petroleum (yellow) and in alcohol (pink), and also by comparative spectrographic examination of myxoxanthin and its oxime. Reduction of myxoxanthin by aluminium *iso*propoxide gives the alcohol myxoxanthol, which is spectroscopically identical with both γ-carotene and rubixanthin. Myxoxanthol therefore possesses a chromophoric grouping of one cyclic and 10 acyclic ethenoid linkages in unbroken conjugation, and consequently in myxoxanthin a carbonyl group must be situated at C_{21} in a γ-carotene skeleton, the only possible alternative (at C_4, ring A) being excluded by the biological activity of the pigment. The unlocated ethenoid linkage may be Δ^{22-23} or Δ^{23-24}, either position being compatible with the observed optical inactivity of myxoxanthin. A decision in favour of Δ^{22-23} has been reached by a comparison of the results of spectroscopic examination of myxoxanthin and of carotenoid pigments of known constitution. Characteristic of the class to which myxoxanthin belongs, is a single broad band as contrasted with the normal triplet spectrum of carotenoids having a carbonyl group terminating the chromophoric system. The conclusion is reached that the single-banded spectrum of such pigments is due to the simultaneous conjugation of the polar carbonyl group with two sets of unsaturated linkages.

Heilbron and Lythgoe have also isolated from *Oscillatoria rubrescens* a new pigment *myxoxanthophyll*, $C_{40}H_{56}O_7$ ($\pm$ 2 H), but in insufficient quantity to determine the structure. The tenacity with which it is retained by adsorbents indicated the presence of a multiplicity of hydroxyl groups. The absence of polar groups conjugated with the polyene system is suggested by the fact that the alcoholic solutions are coloured only yellow to orange red.

T. S. W.

Ultrafiltration by a Centrifuge Method.—The ineffectiveness of ultrafiltration technique in concentration of colloids is principally due to clogging of the ultrafilter membrane by a deposit of the disperse phase; this reduces the filtration velocity very much or even stops it altogether. Since even a thin deposit of the disperse phase is often quite effective in bringing down the rate of filtration, the incorporation of stirring or scraping devices does not help very much. Brinkman and Steinfoorn (*Biochem. J.*, 1936, **8**, 1523) have eliminated this difficulty by an ingenious device. The liquid to be ultrafiltered is kept in a small cylindrical unglazed porcelain pot coated with an ultrafilter membrane and centrifuged. The centrifugal force not only provides the necessary pressure for ultrafiltration but is also helpful in another way. Any peripheral part of the liquid which gets concentrated and hence increased in specific gravity is centrifuged towards the bottom and thus clogging is prevented. As the experiments show, comparatively large quantities of the ultrafiltrate are obtainable by this method. K. S. G. D.

The Neutrality of the Neutron.—Chadwick's original proof that neutrons are unaffected by electric field were really made with fast neutrons. P. B. Moon (*Proc. Phys. Soc.*, 1936, **48**, 658) has carried out experiments with slow neutrons having thermal energies. The results show that the neutron possesses, if at all, an amount of charge much less than 10^{-7} times that of an electron. K. S. G. D.

Routine Determination of Boron in Glass.—Francis W. Glaze and A. N. Finn in a recent paper (*J. Res. National Bureau of Standards*, 1936, **16**, No. 5) describe the procedure adopted and the results obtained by a new method for determination of boric acid in specimens of glass. The method depends on the "partition" of boric acid between water and ether in the presence of ethanol and hydrochloric acid. The partition coefficient can be calculated roughly from the relation $K = 0.673 - 0.054 \sqrt{t}$ and is equal to 0.403 at $25 \pm 2°$. The boric acid in the ether layer is estimated volumetrically by titration with standard alkali.

A study was made of the extent to which the other elements present in glass interfered with the method. It was found that the usual amounts of lime, magnesia, alumina, soda, iron and arsenic did not interfere, but barium, fluorine and large amounts of iron interfered slightly. Zinc, however, was found to interfere seriously.

Amounts of boric oxide ranging from 0.7 to 16 per cent. could be estimated rapidly and accurately by this method. K. R. K.

Absorption of X-Ray by Lead Glasses and Lead Barium Glasses.—By George Singer (*J. of Res. of the National Bureau of Standards*, March 1936, **16**, 3).—The object of this study was to determine the X-ray protective properties of flint and barium-flint glasses and to correlate them with their chemical composition as well as with their physical properties such as density and refractive index.

Adequate details are given of the experimental arrangement and procedure adopted.

The X-ray opacities of the materials were determined by an ionisation method. That thickness of lead which gave the same ionisation current as the sample was taken as its lead equivalent.

The results obtained enabled the formulation of several empirical relationships. In the case of flint glass, its protection coefficient was correlated to (*a*) density, (*b*) refractive index and (*c*) chemical composition, thus enabling the protection coefficient of a sample to be predicted from a knowledge of its density, refractive index or chemical composition. The values calculated from these formulæ were found to be in good agreement with the results of experiment.

In the case of barium-flint glass, an empirical relation is given between the protection coefficient and the lead oxide and barium oxide components of the glass. K. R. K.

SCIENCE NOTES.

Vacuum Production.—The exacting demands of high vacuum technique in research and in laboratory practices are, to a large extent, met by the rotary pumps manufactured by the Central Scientific Company (Agents for India: The Scientific Instruments Co., Ltd., Allahabad). The latest and largest of these, the "Cenco Hypervac 100" represents a great achievement in the design and construction of pumps for high vacuum production. It is a completely self-contained 3-stage pump, with a displacement of 16 litres per second. It dispenses with the need for water cooling; and for working a pump of its size, has a small power requirement—1.5 H.P. Even at low pressure (1 micron and below), the pump is unusually rapid for an oil-sealed pump. It is already finding application in commercial practice for exhausting large vacuum chambers and in the research laboratory it will find numerous uses. The manufacturers cordially invite correspondence regarding the "Cenco Hypervac 100".

* * *

We acknowledge with thanks receipt of the following:—

"Bulletin of the National Academy of Sciences," Vol. 6, Part III, August 1936.

"The Agricultural Gazette of New South Wales," Vol. XLVII, No. 10, October 1936.

"Journal of Agricultural Research," Vol. 53, Nos. 2-3, 4.

"Monthly Bulletin of Agricultural Science and Practice," Vol. 27, No. 9, September 1936.

"Journal of Agriculture and Livestock in India," Vol. VI, Part V, September 1936.

"The Philippine Agriculturist," Vol. XXV, No. 5, October 1936.

"Journal of the Royal Society of Arts," Vol. LXXXIV, Nos. 4375-4378.

"Biochemical Journal," Vol. 30, No. 9, September 1936.

"Communications from the Boyce Thomson Institute," Vol. 8, No. 3, July-September 1936.

"The Calcutta Review," Vol. 61, No. 1, October 1936.

"Chemical Age," Vol. 35, Nos. 900-903.

"Journal of Chemical Physics," Vol. 4, No. 10, October 1936.

"Berichte der Deutschen Chemischen Gesellschaft," Vol. 69, No. 10.

"Russian Journal of General Chemistry," Vol. VI, Nos. 7 and 8.

"Experiment Station Record," Vol. 75, No. 3, September 1936.

"Rothamsted Experiment Station Report for 1935."

"Transactions of the Faraday Society," Vol. XXXII, Part 10, October 1936.

"Indian Forester," Vol. LXII, No. 11, November 1936.

"Indian Forest Records," Vol. II, No. 7.—'Entomological Investigations on the Spike Disease of Sandal (27) *Coreidæ* and *Berytidæ*.'

"Forschungen und Fortschritte," Vol. 12, Nos. 28-30.

"Transactions of the Mining and Geological Institute of India," Vol. XXXI, Part 2, September 1936.

"The Quarterly Journal of the Geological, Mining and Metallurgical Society of India," Vol. VIII, Nos. I and II, March and June 1936.

Government of India Publications:—

Indian Meteorological Department (Scientific Notes), Vol. VII, No. 70.—

"Indian Trade Journal," Vol. CXXXIII, Nos. 1582-1585.

"Annual Report of the Imperial Institute of Agricultural Research," 1935-36.

"Publications of University of Illinois," Vol. 34, Nos. 13, 15, 17, 18, 19 and 22.

"Communications from Kammerlingh's Onnes Laboratory (University of Leiden)," Nos. 229-240. Supplement 78.

Publications from League of Nations, "Quarterly Bulletin of the Health Organisations," Vol. V, No. 3.

"Mathematics Student," Vol. IV, No. 2.

"Review of Applied Mycology," Vol. 15, Nos. 8 and 9, August and September 1936.

"Bulletin of the Madras Government Museum," 1936," Vol. III, Part 2.

Department of Industries, Bombay Presidency, Bull. No. 10.—'Possibility of Production of Aluminium in Bombay,' by Dr. M. S. Patel. "Industrial Research Bureau, India, 1936, Bulletin No. 3."

"Journal of the American Museum of Natural History," Vol. 38, No. 3, October 1936.

"Nature," Vol. 138, Nos. 3491-3494.

"Indian Journal of Physics," Vol. X, Part V.

"Research and Progress," Vol. II, No. 4, October 1936.

"Canadian Journal of Research," Vol. 14, No. 9.

"Science and Culture," Vol. II, No. 4, October 1936.

"Science Progress," Vol. 32, No. 122, October 1936.

"Scientific American," Vol. 155, No. 5, Nov. 1936.

"Indian Journal of Venereal Diseases," Vol. 2, No. 3, September 1936.

"Indian Journal of Veterinary Science and Animal Husbandry," Vol. VI, Part III, September 1936.

Catalogues:

"New Books, Autumn, 1936" (Messrs. Edward Arnold & Co., London).

"Monthly List of Books, on Natural History and Science," October 1936 (Messrs. Wheldon and Wesley, Ltd., London).

"Aids for Modern Visual Education," (Messrs. Bausch and Lomb, Rochester, New York).

Erratum.

Page 231, L.H. Column, Line 8, *for* 20 lakhs *read* 2 lakhs.

SUPPLEMENT TO "CURRENT SCIENCE".

Vol. V] November 1936 [No. 5

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

Blackpool, 1936.

Mathematical and Physical Sciences.

President: PROF. ALLAN FERGUSON, M.A., D.Sc.

TRENDS IN MODERN PHYSICS.

PROF. ALLAN FERGUSON commenced his Presidential Address to the Section A of the British Association by referring to the losses which Physical Science had suffered during the previous year by the death of McLennan, Glazebrook, Petavel and Pearson. McLennan was a versatile and energetic investigator and director of research, whose contributions ranged from cosmic radiation and spectroscopy to cryogenic work and radium therapy. Glazebrook was a veteran of a previous generation whose fittest monument was the National Physical Laboratory. The work of this great Laboratory was further developed by Petavel, who, though known as an engineer, was also a contributor to Physical Science. Pearson will always be remembered in connection with his development of statistical method and its application to biometrical investigation. His *Grammar of Science* develops a point of view which should not prove unhelpful to the student of to-day who would fain remain a physicist without of necessity becoming a metaphysician.

Turning now to the subject of the address, Prof. Ferguson characterised nineteenth-century science and particularly Victorian Science as showing a simple realism not wholly unrelated to that simple realism of to-day which sees in an α-ray track evidence for the existence of an atom of the same order as that furnished by a diffraction photograph (or, for that matter, of our own eyes) for the existence of a star. The classic outlook was based on the notions of velocity, acceleration, momentum and force which were formed into an ordered scheme by the genius of Newton. The physical science of the eighteenth and nineteenth centuries was occupied in extending and clarifying these concepts, although the formation of a society at Cambridge "to inculcate the principles of pure *d*-ism and to rescue the University from its *dot*-age" was required before the British physical school could rival the advances of their Continental brethren. In spite of these attempts at clarification, fundamentals remained obscure enough: thus mass was the product of volume and density while density could only be defined as mass divided by volume.

The nineteenth century also saw the rise of atomic theories and the many successes of extrapolating the laws which described the motion of planets to the indescribably small atoms. It is an odd fact that in the modern days of probability and indeterminacy we should also see atomic constants determined with greater accuracy than before. However, the British could remember with pride that it was Joule who first evaluated a molecular constant, *viz.*, the mean speed of a Hydrogen molecule at 0 °C. as 6055 ft./sec. in a paper published in 1848. Joule was also responsible, as is well known, for the recognition of the equivalence of heat and energy. Another outstanding feature of the 19th century was that success of the ether theories which led Kelvin to say "This thing we call the luminiferous ether... is the only substance we are confident of in dynamics. One thing we are sure of, and that is the reality and the substantiality of the luminiferous ether." However, the end of the century already saw this conviction totter in the presence of the problem of the distribution of energy amongst the various wavelengths comprising the radiation from a black body. A satisfactory theory could only be given by "quantising" the energy of an oscillator, *i.e.*, by restricting its values to integral multiples of a unit $h\nu$, as was shown by Planck. Another phenomenon which was inexplicable on classical lines but could immediately be explained by means of Quantum Theory was the photoelectric effect. The discrete lines of the spectrum of hydrogen, for example, could only be explained by assuming that electrons were confined to prescribed orbits in which they did not radiate as required by classical theory. The success of this theory of Bohr and its extension by Sommerfeld was large but the more complex spectra required the notion of spin and Pauli's principle before a model capable of explaining them could be found.

In the meanwhile the discovery of the Compton effect emphasised the corpuscular nature of light, while interference, diffraction and polarisation were still explicable only by means of a wave concept. This duality was successfully extended to matter particles by de Broglie who attributed a wavelength h/mv to a particle of mass m and velocity v. This dualism between particles and waves has in recent years been interpreted by correlating the amplitude of the wave at any place with the probability of finding the particle in that position. The particle

conception is still at the bottom of all the attempts made to bombard atoms with fast moving projectiles. To the number of such projectiles there have been notable additions in the form of accelerated protons and, more recently still, fast and slow neutrons. The investigation of cosmic rays has led to the discovery of the positive counterpart of the electron, *viz.*, the positron. In all the nuclear transformations studied, Einstein's law of the equivalence of mass and energy has been amply verified with great accuracy. Very recently, however, the validity of the law of conservation of energy in individual atomic processes has been called in question as a result of experiments on the Compton scattering of γ-rays.[1]

Another remarkable discovery is that of artificial radioactivity. Thus while Rutherford showed in 1919 that on bombarding nitrogen with α-particles we get oxygen and a proton, Curie and Joliot have shown that on bombarding aluminium with α-particles, neutrons are emitted and the remaining isotope of phosphorus is radioactive giving out positrons. Neutron bombardment also produces new radioactive elements which emit positrons or electrons and sometimes γ-rays also and are thus β-active.

The theoretical side has seen the enunciation of the much discussed uncertainty relations, *viz.*, that the product of the errors in two conjugate quantities like energy and time or position and momentum can never be less than the quantum h. It seems however that the word "indeterminism" applied to this principle is based on an extension of the strict meaning of that word. The word "observable" has been similarly treated. The "observable" as understood to-day, such as the frequency of a spectral line, is as far from being a direct percept as an electron-state which is dubbed an "unobservable". It is, therefore, more profitable to develop a canon to serve as a guide through the maze of new perceptual facts by adopting the method discussed in the *Grammar of Science* with some reservations and additions. The term "causality" as discussed by philosophers like Locke, Hume and Mill connoted an unconditional invariability of succession. The trend in physics is to devise a conceptual world of atoms and molecules to assist us in correlating the huge mass of our perceptions to get a simple description. But so long as these concepts do not become objects of perception it is useless to discuss their reality. Thus Planck, who defines an event as causally conditioned if it can be accurately predicted, escapes from a denial of causality on account of the necessarily uncertain character of predictions allowed by Quantum Theory by assuming causality to hold in a conceptual world where accurate predictions are possible. A conceptual world of quantum physics is framed in which a strict determinism reigns. This, however, is not so similar to our conceptual world as one consisting of billiard-ball atoms was. Accordingly the hard-pressed physicist of to-day is on safe ground only so long as he does not confuse the concept with the percept. Further, since Japolsky has developed a theory of the elementary particles on the basis of classical electrodynamics, the solution offered by quantum physics is not final.

Concluding, Prof. Ferguson referred to the remarkable advances made in industrial applications of physics, such as the flotation process for the separation of minerals which depends on a nice application of a knowledge of surface constants such as the angle of contact. He referred also to the observation of the Brownian movement of delicately suspended balances, the study of surface structure by means of electron diffraction, and the progress of low-temperature research. Finally he touched upon the "Impact of Science on Society" and said that a snobbish distinction between cultural and vocational values could not be maintained and the fact must be faced that there are dysgenic applications of science. Therefore the scientist must cease his worship of what Prof. Hogben calls the "Idol of Purity" and must be prepared to discuss all the social implications of his work and to educate himself as well as his less fortunate brethren in a knowledge of these implications.

Chemistry.

President: PROF. J. C. PHILIP, O.B.E., D.Sc., F.R.S.

THE TRAINING OF THE CHEMIST FOR THE SERVICE OF THE COMMUNITY.

THOSE who may be harrowed by the horrors of civil strife in Spain, the temporary breakdown of the League of Nations and the contemplated possibility of a war to end civilisation, will find in the presidential address of Professor Philip a soothing palliative. Placidly, and at uniform speed we are led through a survey of the services rendered to the community by the chemist, to consideration of the most appropriate professional equipment with which the chemist should be furnished. In fact, the only suggestion of current alarms is a comical picture of popular misconception in regard to chemical research as applied to warfare.

On this point, and on this point only, Professor Philip allows himself some justifiable display of dignified irritation. "The truth is that the employment for other than beneficial ends of substances discovered by the chemist is due, not to his especial wickedness, but to the weakness and backwardness of the human spirit." The truth, having regard to the decorous limits imposed by a presidential address, could scarcely be stated more concisely. He fortifies it by reminding us that the dangerous and poisonous materials produced by chemists arose in the general quest for knowledge, and that many have applications both legitimate and valuable; nitrates and phosgene for example. He could have added that mustard gas, discovered in 1860 by Guthrie, remained a chemical curiosity until July 1917, when it was first used as an offensive agent by the Germans at Ypres: and that chlorine, discovered in 1774 by Scheele, was widely used for bleaching, disinfection and artificial dye-manufacture during decades before the Germans broke their promise, and began the whole disgusting business on April 22, 1915. Actually the pre-War production of chlorine for peaceful purposes in the United States alone averaged 900,000 pounds *per day*.

1 [Recent work by a number of investigators has shown that the doubt is unfounded.]

It is the peaceful purposes to which chemists apply their craft that Professor Philip emphasises, and from the tranquil paragraphs of his address the general reader will gain sorely needed information thereon. He notes with satisfaction the increasing interest shown by the State in the prosecution of these purposes, illustrated by the foundation of the Department of Scientific and Industrial Research followed by the Chemical Research Laboratory at Teddington where, under the skilful direction of Sir Gilbert Morgan during the past ten years, the study of synthetic resins, low-temperature tars, high-pressure reactions, metal-corrosion, chemo-therapy and water softeners, has been pursued by a large staff of trained chemists. Even the State is not yet fully informed on the functions of chemical practitioners, however, and if it can be said to possess knuckles, these are discreetly rapped by Professor Philip with reference to a recent lively wrangle that sprang from the drafting of rules for manufacture of pharmaceutical preparations containing poisons.

The lofty ideal of the medical profession, "serving the community," is quoted as a seemly example for the chemist, and even if this has acquired now-a-days a slightly advertisemental air, it is nevertheless a wholesome slogan. Most chemists who have leisure to extend their analytical habits to their own feelings, however, would probably find that their principal non-profit motive is to serve chemistry; and that if one of the by-products be serving the community, so much the better. Elimination of the profit-motive, especially among servants of the community so notoriously underpaid as chemists, is not so easy; and even Professor Philip himself would seem to be slightly infected with it when, in the next paragraph, he calls for a corporate body to "stand for the common interests of chemists as a whole".

On this question also the address is informative and sound. Tracing the history and purposes of the three large chartered bodies, the Chemical Society, the Institute of Chemistry and the Society of Chemical Industry, and mentioning the numerous ancillary organisations more recently springing from divergent activities, Professor Philip shows how the Chemical Council has arisen, in the ultimate hope of unifying the profession, acquiring adequate premises and establishing a complete register of trained chemists. This rosy prospect has been given seven years—two of which have already passed—for fulfilment, and it is to be greatly hoped that, even if the licensed hours require slight extension, the lions and the lambs will ultimately lie down together. Meanwhile, the Council contents itself with uniting the chemical profession and the chemical industry in support of publications and a central library.

There follows a thoughtful survey of the preparation essential to qualification as a registered chemist, non-pharmaceutical. Its basis must be a broad, general education for character, culture and citizenship, with due regard for accuracy in observation and statement. Professor Philip will have many supporters in regretting the absence of biology from this early stage of training, which he ascribes to the greater facility with which elementary instruction in the physical sciences can be arranged. His urbanity debars him from characterising this omission as laziness, and it is in fact more probably owing to the unfortunate action of London University in changing biology, for the Intermediate Science examination, from a compulsory to an optional subject. This was a real disaster, because even a zoological horizon limited to dissection of the frog, rabbit, dog-fish and earthworm enables you at least to glimpse the theatre of biochemical changes to be studied later, although it is merely a gallery-view.

Professor Philip scents danger at a further stage. Graduates in chemistry "can talk at length about nuclear spins, valency angles, electron sinks, energy levels and so on, but are astonishingly uncertain about more elementary and practical matters". Coming from a physical chemist these words are innocent of bias, and are followed by passages of wisdom relating to co-ordination of knowledge and action in university training; these include a survey of requirements by seekers after training in chemical engineering, which will soon become a degree-subject in the University of London.

Nobody interested in the training of chemists, or, indeed, of science-students in general, should fail to read Professor Philip's address. Besides a plenitude of information and common sense, it offers a refutation of the gibe, unhappily sometimes warranted, that men of science cannot write good English, and in this respect also is an admirable example of an address that is really presidential.

Geology.

President: H. L. HAWKINS, D.SC., F.G.S.

PALAEONTOLOGY AND HUMANITY.

TO the layman Palæontology is a comparatively unknown science and the work of the Palæontologist is looked upon more with curiosity than conviction. The responsibility for this rests upon the system of education obtaining at the present day and it is the purpose of this address to demonstrate that even Palæontology has a message of vital importance to deliver to mankind.

The object of Palæontological work is to unravel and decipher the records of past life and thus to enable us to adequately appreciate and establish its continuity since early geological times.

Although the time is now past when men in their senses looked upon fossils as freaks of nature, thunderbolts or even ascribed their origin to astrological conjunctions, still old prejudices die hard. But as summed up by Breynius in 1732, a person who would even now deny the true nature of fossils must "assuredly have a fungus for a brain". It was late in the 18th or early 19th century that students of Geognosy, instead of confining themselves to museums and libraries, began to work in the field and to investigate fossils of their own collection. Thus sprang up two sciences and "geology, as we understand it to-day, found in fossils the link that gave continuity to a mass of disconnected observations;" while "Palæontology took its place as the science of the succession of life." The discovery that strata could be correlated and their relative geological ages established is one of the greatest of modern times, for to it we

owe our conception of geological time and the fact of evolution.

There are difficulties that the Palæontologist has to face, difficulties due to the imperfection of the geological record, to the breaks in the stratigraphical succession marked by unconformities and to our own imperfect understanding of the available evidence. There are gaps due to biological factors, for animals and plants without hard parts are completely destroyed.

On account of these limitations the taxonomic divisions proposed by the Palæontologist are bound to be different to those of the Zoologist, who is able to study both the soft and hard parts of the organism. But the biological palæontologist is less concerned with genera and species than with series and trends. In large measure the subdivision into genera and species is tentative. "It gives convenient, but often false, means of expressing morphological qualities. Such familiar 'genera' as *Gryphæa* and *Exogyra* can be shown to represent stages in the morphogeny of oyster-shells belonging to manifestly different lineages."

By a detailed study of the fossil specimens and the nature of the matrix in which they are embedded, or by comparison with related organisms living to-day, we can deduce the physical conditions relating to climate—temperate, tropical or arid, and environment—marine, freshwater, fluviatile, etc., prevalent at the time of their burial several thousand or even million years ago. It is also known that the survival periods are not the same for the different groups. Some groups are short lived, others have survived throughout the known range of geological time almost since the Cambrian onwards.

It has been fairly established that simplicity of structure combined with efficiency is associated with durability, while specialisation is a sure sign of early decay and possible extinction, for if the environment changes, the organism is unable to adapt itself rapidly enough to changing circumstances. To cite instances, the genus *Cidaris* has persisted with no important modification from the Triassic period to the present day. *Echnocystis* is limited in range to the Upper Silurian. *Heterosalenia* lasted from the Upper Jurassic to the Upper Cretaceous only. Now *Echinocystis* and *Heterosalenia* were both much more elaborate in structures than *Cidaris* so that their short ranges illustrate the generalisation made above. But there are exceptions.

While environment exerts an important influence on the organisms, the major physiographical paroxysyms are often responsible for their decline, but with the decline of one group, the rise of some other group often occurs as an attempt by nature to maintain the equilibrium of life, as it were. Thus the fall of the Nautiloids was compensated by the rise of the Belemnoids, that of the Reptiles was followed by the advance of the Mammals. This may be explained on the ground that the extinction of one group diminishes the intensity of the struggle for existence for the other groups.

An important point bearing upon the evolution of forms is that certain characters, whether their direction was predetermined at the outset, or whether they were induced and selected by circumstances at an early stage, once started, continue to develop in the same direction to a limit that they become a source of weakness and may ultimately be the cause of extermination of the organism that possessed them.

Palæontology affords no evidence at all as to the ultimate origin of various groups or of the manner in which life arose, though we have abundant proof of relationship and descent during the course of geological time. And this at least has been definitely established that the life-history of an individual represents, in an abbreviated form, the life-history of its species, that of the species the history of the genus to which it belongs; the generic history in turn represents the family history in a shorter span.

We now come to the application of palæontological principles to the evolution of man and the human race. One important point must be borne in mind, namely, the brevity of the geological history of man on the globe owing to which very little structural change has come about.

The principal characters that distinguish the human species from others are its upright posture, its capacity for intelligent speech and other mental powers. By the exercise of his intelligence, man is able to overcome difficulties and compensate himself for his structural shortcomings. He can, to a certain extent, overcome the influence of environment, which is an important factor in the evolution of other groups, but bereft of his intelligence, in other respects, he is no better fitted to stand the vicissitudes of environment than an animal.

Now specialisation in one particular direction is a sure sign of decadence and ultimate extermination, and thus high cerebral specialisation points to a rapid and spectacular rise and an equally sudden fall of the human race. But we may look at this from another view-point, that this type of specialisation, on account of its wide scope, its control over environment and over natural destructive forces, is not really specialisation but extreme generalisation and, therefore the human race may yet have a long history before it.

It may therefore be said that paradoxically man "has become supremely generalised by the exercise of a highly specialised faculty."

Palæontological evidence is more reliable than facts of history recorded by men because it is neither influenced by personal outlook, nor tainted with prejudice and deliberately falsified, as human documents sometimes are. A revolution that might have been the salvation of a country according to some may be regarded as a perversion of human capacities by others.

Finally the causes that lead to the decadence of the dominant races and empires are varied. The most important of these are complexity and over-specialisation in one particular direction and internal discord, which results, when the component parts, having struggled together to attain a position of dominance, begin to struggle among themselves, instead of working in harmony. There is then a remarkable correspondence between the behaviour of races and empires and the evolutionary trends of animal groups. Those who deny the truth of the statement surely misread the lines :—

Ill fares the land, to hastening ills a prey,
Where wealth accumulates and men decay.

M. R. SAHNI.

Zoology.

President : J. S. HUXLEY, M.A., D.Sc.

NATURAL SELECTION AND EVOLUTIONARY PROGRESS.

MODERN research in Biology has emphasised above all things the necessaity of synthetic frame of mind to explain evolutionary phenomena. That selection alone or mutation alone cannot produce evolutionary change is the most important outcome of post-War biological thinking and it is becoming increasingly clear that the two processes are neither alternative nor competitive but perfectly complementary. The findings of geneticists have tended to show that the effect of a given gene does not rest within itself but is the outcome of the co-operative action of a number of associated genes, so that we now are concerned with a gene complex. Therefore mutations when they are dominant or recessive, become so through the action of other genes in the gene complex. But the fact remains that most mutations so far investigated are deleterious, and the question will be asked, if mutation is the directive source of change, should it not be advantageous also? That very slight gene differences producing extremely small effects exist has been shown by recent analysis and it is more than likely that these may be the initial factors of evolutionary change. Again, a certain mutation that is harmful in a certain environment may be useful in another as has been shown in the vestigeal winged mutant of *Drosophila* and a few other cases. So that in a Mendelian world, the basis of evolutionary change is a co-operative effort between mutation and natural selection.

It is becoming increasingly clear too that the processes of evolution are very complex involving a number of smaller processes. The origin of species can now no longer be thought the whole of evolution. It is only one of the processes. It is now clear that the origin of new species from pre-existing ones must take place in several different ways. A gradual transformation may bring about the result along two divergent lines. A sudden separation may also occur. Hybridisation is another powerful tool in the hand of Nature resulting in a great complexity of characters which help in species formation. In all these cases physiological as well as geographical isolation is involved. And from the standpoint of natural selection, species will then fall into two contrasted categories. Specific characters which are different from others initially and abruptly could not have been produced by natural selection but in species where character modification is gradual, natural selection must have played an important part in species formation.

The origin of adaptations is another process of evolution. While it is true that one-character, single-step adaptations do exist, generally "most adaptations clearly involve many separate characters" which could not have arisen by mutation alone but which must have been brought about by "some agency which can gradually accumulate and combine a number of contributory changes: and natural selection is the only such agency that we know."

Recently much work has been done to evaluate the importance of the rate of action of genes. "A large number (possibly the majority) of genes exert their effects through the intermediation of a process operating at a definite rate. The speeds of processes with such rate factors control are not absolute, but relative—relative to the speeds of other processes of development and of development in general." The bearing of this on the interpretation of the diverse phenomena of development is considerable and probably the rate of every developmental process is gene-controlled, providing us a clue to the clearer understanding of the evolutionary aspect of recapitulation, neoteny, fœtalisation, clandestine evolution and apparently useless characters.

But natural selection alone has repeatedly produced results as unfavourable as they were unexpected. It is no longer true that natural selection must always be for the good of the species and this is especially so if it is intraspecific and if it is taken to an extreme. The result is often the production of unbalanced organisms whose existence becomes intensely precarious. The result of natural selection is not always progressive improvement; indeed, it is only rarely so. And by no means is it the best mechanism for achieving evolutionary progress.

The process of evolution has been so far one of progress though it has been limited to a few stocks and though it has often resulted in specialisation. In Nature, there is a very thin line between progress and specialisation and while one may lead to further improvement, the other often results in extinction. But what is the general trend of evolution of the future? Man's peculiar way of living and the dawn of conceptual thought in him have made him less susceptible to nature's laws. So that future progress of man must largely rest with man himself. He must formulate for himself a purpose and this purpose must guide the destiny of every individual and the whole race. Many efforts have been made to define this purpose. But what a task?

Geography.

President : BRIGADIER H. S. L. WINTERBOTHEM, C.B., C.M.G., D.S.O.

MAPPING OF THE COLONIAL EMPIRE.

"MAPS are potted information about environment and about man. They are indispensable to us, and at the moment, we are, as regards their production, in the trough and not on the crest."

This is the central theme of Brigadier Winterbothem's presidential address to the section of Geography. Undoubtedly, the first step towards man's comprehension of the physical world around him is its mapping. A chart or a map is not merely a record of the terrain around a given locality, but is also a background against which many details might be depicted.

An outstanding feature of the science of mapping at the present moment is the paucity of maps which give all the information which we have learnt to expect of them. The importance of good maps to administrators can hardly be overrated. It is said that the very backward state of mapping in the United States is due to the fact that the country is rich enough to survive the handicap of indifferent map-making. This warning note must serve as an eye-opener to all, and nations must seriously question themselves

whether they are rich enough to survive a similar handicap. In 1922 in England the order of the day was frugality and building " a land for heroes". Ambitious building programmes were planned, while the survey vote was cut down to the barest minimum. This policy is somewhat akin to the wisdom of an elderly gentleman who, when he has out-grown his old suit of clothes, orders a new one with strict injunctions to the tailor to use a yard less cloth.

Maps are useful not only for what they show, but for what they may be made to show. It is of interest to see in this connection what the British National Survey has done to evolve the modern map.

At first the Geological Survey started an Ordnance Geological Survey and the first 10-mile map was prepared for the River Commissioners, and others were produced at a joint call of archæologists, geologists and soldiers. Population maps helped to delimit inter-state boundaries. Archæological and historical maps emerged as by-products of the mapping of the relevant sites usually as a function of the Ordnance Survey. The position in respect of map-making is not so bad in Great Britain as it is in some of her dependencies. In the areas administered by the Colonial Office, the first step towards seriously attempting the problem of map-making was the establishment of the Depot of Military Knowledge as a branch of the Quarter-Master General's Department. But this department which began with fair promise passed imperceptibly into a state of suspended animation after the defeat of Napolean, and was not revived till the Crimean War. In 1855 the idea, that a department of Geography should be attached permanently to the Foreign Office, originated by a certain Major Jervis, took effect and a " Topographical and Statistical " department was founded. For some time, this department and the Ordnance Survey (essentially a domestic survey) were coalesced under a single director, but financial stress cut them asunder; the topographical department concerning itself with the especial task of overseas and colonial map-making. The first map produced by this section was that of Africa, compiled from a miscellaneous horde of data that had accumulated by random collection. Another large and important series produced under the same auspices, was that of Asia Minor which was still the best map extant of that region at the beginning of the War. Since the War the Geographical Section has produced two very important series of maps, *viz.*, the ¼-M of Asia and the ½-M of Africa which are remarkable alike for accuracy and painstaking execution.

To-day the most important factor in map-making is reliable ground survey. Surveying, in general, consists of two branches, *viz.*, property survey and topographical survey. Property survey is the concern of private practitioners, who carry them out for their clients; while topographical survey is conducted for the State by soldiers. In Africa the property surveyor was the first to be active and his activities date back to the early Dutch settlements at the Cape. British colonial development owes a lasting debt to the pioneer Royal Engineers who made possible the construction of roads and railways and cathedrals and government houses not to speak of the towns themselves.

A step forward towards the fusion of the property and topographical surveys was taken when the astronomer entered the field. It was due to Sir David Gill that the triangulation of the Union of South Africa was initiated and completed, and it was his ambition to see that it was carried through till it joined the Egyptian triangulation completing an arc roughly along the 30° E. meridian of Greenwich.

The War period saw the complete cessation of all mapping and revision in Great Britain. But in Africa this was by no means the case. A good deal of East Africa was learnt, and improvement and compilation of the more generalised maps were seen through on account of dire necessity. Since the War, however, there has been little progress compared to what was achieved during the previous period. Land surveying did record some improvement and triangulation was steadily carried on by Mudge in England and Everest in India. The next important step in the advance of colonial survey was to build up a department which is both economical to run and is graded into specialised branches. This was of the utmost importance to Africa as both money and labour were being expended uneconomically. As a result of the recommendations of General Hills, Sir Gordon Guggisberg began to introduce a progressively increasing native element into the survey department of Nigeria and the Gold Coast. Gradually this practice which had its precedent in India is gaining ground in the other British Colonies.

An important addition to the surveyors equipment in modern times is the advent of aerial surveying which has made considerable contributions to his bill of fare. As a method this is without rival as it is invaluable to the surveyor while surveying inaccessible ground.

Despite the rapid advances which surveying in all its phases has registered, topographical mapping in the colonies is showing signs of decay and compared to the pre-War record the post-War achievements present a melancholy contrast. For instance, there is a certain British West Indian Island which is " insisting on remaining unmapped " and thereby saddling the fruit industry with an extra annual expenditure of a thousand pounds. Again in many of the boundary demarcation expeditions local officials are being increasingly employed instead of imperial parties and so we have failed to secure proper boundary mappings.

The most serious problem for the future in colonial mapping, is the overhauling of the machinery as a whole. It must not be concluded, however, that the Geographical Section is idle to-day. It has inaugurated periodical conferences of empire surveyors, and has started the *Empire Survey Review* which can be ranked as the best of its kind in the world; and the surveyors themselves have co-ordinated the various aspects of their work. But it is " the trust in the higher beings which has failed". The fault mainly rests with the fact that public opinion in England is slow to grasp the real situation in Africa and the position is worsened as there are few good maps on which the public can work. Past experience has taught that social, economic or industrial development cannot be divorced from land surveying and it is the urgent necessity of the day for geographers to forward this matter, in the interest of colonial development.

Engineering.

President: PROF. WILLIAM CRAMP, D.Sc., M.I.E.E.

THE ENGINEER AND THE NATION.

"THE object of the British Association is to make known, as widely as possible not only the aims and achievements of every science, but also the bearing of each advance upon world conditions. The very fact that engineering was the seventh section to be formed shows that there never was any intention to restrict the activities of the Association to 'pure' as distinct from 'applied' science. Our President was strictly in order when he suggested, last January, that Sectional Presidents should not hesitate to deal with current difficulties and misconceptions in their particular fields of work, and with the reactions of that work upon the community. These are matters that concern the engineer very closely, since his activity is linked with the national life and often consists in the application of knowledge previously secured by the physicist, chemist and metallurgist. He himself is not thereby debarred from fundamental researches. On the contrary, he is frequently led to investigate in detail problems half solved by the physicist, or to discover phenomena which the chemist has missed. No better example could be quoted than the arc-rectifier which from its humble beginning in the investigations of Cooper-Hewitt to its present position as the most important converter in heavy electrical engineering is entirely the work of engineers."

PURE SCIENCE AND ENGINEERING.

"But though engineering has for so many years been regarded as a branch of science by the British Association, there are great and fundamental differences between those engaged in pure science and the engineers. The former may, if they so choose, indulge in a life of ardent detached curiosity, devoting themselves to the observation of behaviour and to the construction of a framework of principles neatly fitting the collected observations. To such men, the known is just a key to the unknown, and the unknown is the one thing worth knowing. This is called the pursuit of truth as distinct from the pursuit of learning."

The function of the engineer is to supply the co-ordinated knowledge of the pure scientist and the experience of the ages to the satisfaction of human desire, and to the increase of the amenities of life. He is the link between human experience and scientific knowledge, and, as such, he cannot perpetually live in a rarefied atmosphere of detachment. He must be in daily contact with humanity and learn to understand human psychology as well as human needs. As a result, he is less specialised, more balanced, more adaptable and understanding than his colleague in pure science. His judgment in human affairs is more developed; he is a better 'mixer'. A nation of pure investigators would be calm and peaceful, but cold as Scotland Yard. A nation of engineers might be quite a pleasant community.

ENGINEERING AND CIVILISATION.

In its purest form, engineering is the greatest instrument of civilisation that the world has ever seen, in the sense that it continually tends to promote a closer contact, a greater intimacy, and therefore a more profound understanding between individuals and nations. Three-fourths of the work of the engineer is devoted to the development of communication. Roads, canals, bridges, railways, harbours, ships, motorcars, aeroplanes, telegraphs, telephones, television, all these and many more are humanity's hypens. Their natural effect is to foster friendliness and dissolve differences. Left undisturbed by the politician, the scaremonger, and the patriot, the engineer would demolish the Tower of Babel and render war impossible. Build a channel tunnel; then Calais and Dover become neighbours and Anglo-French understanding ensues in all senses. Place transmitters in the trenches with receivers and televisors at home; then war becomes unthinkable. The very first thing that a government does on going to war is to seize and control every means of communication and every engineering device that might otherwise serve to unite the combatants. For the promotion of peace and understanding, engineering easily outclasses every religion; and for battle, murder, and sudden death it has no equal.

STATUS OF THE ENGINEER.

At all times, in peace or in war, the engineer must be intimately concerned with human relationships. This fact gives him proportionately greater opportunities both for the development and for the loss of character: his chances of salvation and of damnation are alike increased. For character does not mature in cloisters and exposure is necessary to prove immunity. To what extent do his fellow subjects recognise this national importance and this difficult dual rôle; and to what extent does the engineer abuse his unique position or allow himself to be made the tool of less scrupulous men?

The engineer now has the liability without the status. The doctor or barrister has fairly acquired the status; but the organisation to which he belongs tends, as I think unwisely, to shield him from the healthy breeze of liability.

REMUNERATION OF THE ENGINEER.

The contrast between the remuneration of the engineer and that of the other professions is very striking. The doctor or the barrister at equal ages gets very much more than an engineer. Consequently, the output of original work from the medical schools is small compared with other branches of pure and applied science.

CHARGES AGAINST THE ENGINEER.

The first is that he is equally willing to lend himself to works of utility and to works of death and destruction. Remember, however, his dual rôle. Pure science has nothing to do with ethics, she recognises no moral obligations whatsoever. The same explosive that releases coal underground can also kill men in battle. The telephone is useful alike in the home and in the front line trenches. The same bacteria may be beneficial in one case, harmful in another. The same principles that bring the stars within our ken also control the range-finder. There is no scientific apparatus that cannot be misapplied; and to every advantage there is a corresponding drawback. The ear that relishes music is the more sensitive to discordant noise. Not until beauty is seen to be beautiful can ugliness be defined. To the extent that the engineer is a scientist, the use to which his discoveries shall be put

does not concern him. But, it will be urged, the engineer on the human and commercial side designs to make armaments for profit. And if he does, he should be credited with at least as much honesty of purpose as the politician who declares war and orders the guns.

The engineer is charged with the creation of the problem of unemployment by his inventions, such as, the internal combustion engine and various labour-saving devices. But to rid the world of machines needs a change of attitude towards occupation, a love of monotonous work for its own sake, a real desire for real work and not merely for the reward thereof. These, however, seem difficult.

Another charge against the engineer is that they are not fertile or enterprising, nor introduce new industries in distressed areas. But the law of patents right is such that it does not afford real protection to the inventor. To defend a patent or to attack an alleged infringement involves incredible legal expense, and large firms knowing this, will unblushingly copy the invention relying on the inability of the patentee to finance an attack.

Anthropology.

President: MISS D. A. E. GARROD.

THE UPPER PALAEOLITHIC IN THE LIGHT OF RECENT DISCOVERY.

PREHISTORIC studies have received a new impetus during the last 12 years by the multiplication of researches outside Europe. Excavations outside Europe have shown the possibility of a revision of the existing knowledge about the palæolithic cultures. Three important cultural elements of primary importance in the Old Stone Age are manifested in the so-called hand axe industries, flake industries and blade industries. The first two run side by side as far back as can be seen, but the origins of the third may have to be sought much further back. Any attempt to present in an intelligible form the vision of man's earliest history is hampered by a vocabulary which is out of date. The terms Lower, Middle and Upper Palæolithic are used at the same time in a chronological and a typological sense. Miss Garrod however believes that the time has come when the labels Lower, Middle and Upper Palæolithic should be used exclusively in a chronological sense without any typographical connotation to cover approximately the periods from the beginning of the Pleistocene to the end of the Riss Glacial, from the end of the Riss to the middle of the Würm, from the middle of the Würm to the close of the Pleistocene respectively. For purposes of typological classification the three main groups of hand axe, flake and blade cultures are essential and it will be necessary to multiply names derived from type stations to denote the many varieties found within these groups.

The blade cultures of the Upper Palæolithic must have passed through the early stages of their development somewhere outside Europe during Middle or even Lower Palæolithic times though as Miss Garrod admits there exists only the faintest clue as to how and when that development took place. She discusses the type stations in Europe, Asia and Africa and shows clearly the diversity of the strains grouped so far together under the name Aurignacian and also how the blade industries developed their main characteristics at a surprisingly early date.

Perigord, a classic centre for prehistoric studies, indicates a close relationship between the Lower and Upper stages of the Aurignacian. Laugerie Haute finds resemble the industry of Ros del Ser in the Correze and the Upper Chatelperron level. Discoveries of remarkable parietal engravings in pure Aurignacian style in the caves of La Hoz and Las Casares in the province of Guadulaja and the excavations of Senor Pircot Garcia in the cave of Parpallo show that the commonly accepted view that Spain was a Capsian province needs to be modified. The Franco-Cantabric cultures appear to be intrusive in the southern part of the Peninsula and a parallel development from a more or less typical early Aurignacian to a rather finely characterised late industry is probable. Capsian influences appear in the final stages which agree with the late dating of the Capsian as proposed by Vaufrey. Recent study of the Italian blade industries by Vaufrey has shown that they present a single facies corresponding in time with the whole period of the Aurignacian, Solutrean and Magdalenian in France. In the south Russian plain, a probable succession of blade industries has been worked out though this is not yet confirmed at all points by stratigraphical evidence. Typologically the sites discovered fall into two divisions, the first characterised by an industry of Willendorf type and the second by a rather generalised Upper Aurignacian. In Southern Siberia has been found a most remarkable series of objects in bone and ivory and female statuettes carved in bone belonging probably to the Gagarine family. The mixture of Mousterian and Aurignacian forms in the lithic industry is a fact which suggests possible connection with the Far East as the discovery of a similar industry in the lœss along the course, of the Shuitungkou River in Northern China indicates.

The discovery of a highly developed Aurignacian of Willendorf type in the Palæolithic of Southern Kurdistan suggests a connection with the Kostenski I, the earliset known blade industry of South Russia. Excavations in Palestine have established a sequence of blade cultures. Egypt was cut off from the main lines of development in Upper Palæolithic times since blade industries proper are unknown before the appearance of the microlithic cultures. In Africa which still awaits systematic excavation, investigations point to the possibility of true blade cultures arriving late, their place taken up by Aterian with strong Mousterian traditions. The Microlithic facies appeared in Africa perhaps much earlier than in Europe, though it is difficult to maintain this in view of the paucity of evidence. There is no proof, however, that the Kenya Aurignacian is older than the Eurasiatic blade industries and Miss Garrod points out that the late survival of a culture of Mousterian tradition as in Little Africa and Egypt, in the cases of the Kenya Stillbay is certain.

The blade cultures have a wide distribution and it is unlikely that the key to the progress is to be found in Southern France. The French sequence appears to be the result of successive immigrations superimposed perhaps on a certain amount of local variations and development in place. The first blade industry to reach Western

Europe is that of the Chatelperron stage. The Lower Kenya Aurignacian appears to be more or less of Chatelperron type and may be contemporary with this stage in France. A similar, though not identical industry, occurs at the base of the Upper Palæolithic sequence in Palestine. Thus at the beginning of the Upper Palæolithic three areas with similar industries are found. Two of these, Palestine and East Africa, may have been in touch with each other through Arabia and across the Bab-el Mandeb while the third remains apparently isolated.

The Chatelperronian may have developed from the contact of the Acheulean and Levalloisian cultures but it is more probable that Chatelperron had an independent existence, and having developed in some centre still unknown it is an intrusive element in the Acheulean. The original home of Chatelperron industry cannot be Palestine or East Africa but an Asiatic centre seems inevitable. East Africa may possibly be the centre of origin of the Capsian which would thus enter Little Africa by way of the Sahara. The Capsian would thus derive many of its features direct from the Chatelperronian. As for the peculiar industry which closes the Upper Palæolithic sequence in Palestine it is quite definitely Aurignacian rather than Capsian.

The Aurignacian and Chatelperronian appear to have developed independently from an early date. The Gravette-Font-Robert industry has a very wide distribution in Central and Eastern Europe and its remarkable development in this region points rather to a Euro-Asiatic origin. The Capsian and the Gravette-Font-Robert industry are perhaps derived from the Chatelperronian. Though the Gravettian industry appears to be of eastern origin yet Central Europe cannot be regarded as the centre of dispersion as there is clear evidence that the Gravettian is there preceded by the Aurignacian proper. Nor is it likely that the centre of dispersion can lie very much further to the east. In Palestine the true Gravettian is absent and in Southern Kurdistan it probably represents a relatively late migration from Russia. In Palestine the Chatelperronian level shows signs of evolution towards the Gravettian type and it is possible that an industry of this character had already penetrated into Northeast Europe before the westward moving Aurignacian invasion had reached the Mediterranean coast. Thus the Chatelperronian has emerged in the Lower Palæolithic and sent out two branches, one into East Africa to give rise to the Capsian, the other into Northeast Europe to develop into the Gravettian. The Aurignacian pushes westward in the meanwhile and separates these into two great provinces. From Aurignacian and Gravettian centres migrations poured into Central and Eastern Europe and interpenetrations took place along the fringes of the original provinces.

DIRENDRA NATH MAJUMDAR.

Physiology.

President: PROF. R. J. S. McDOWALL, M.D., D.Sc., F.R.C.P.

THE CONTROL OF THE CIRCULATION OF THE BLOOD.

IN his Presidential Address, Prof. R. J. S. McDowall has given an account of the various mechanisms which work together to provide adequate blood supply to any part of the body whatever its activity or whatever the posture of the body. He has dealt with the effects of physical exercise since most of the mechanisms elaborated in his address are brought into operation thereby. Thus when a tissue, *e.g.*, muscle, increases its activity it needs more blood per minute to ensure a proper supply of oxygen and food. This is brought about by variations not only in the activity of the heart but also by a redistribution of blood. The heart can, within limits, increase its output and alter its rate. The heart is under the control of the sympathetic and vagus nerves or rather under the control of two sets of reflexes. In the case of the sympathetic, the source of afferent impulse is not accurately known, but in the case of inhibitory impulses, the source of afferent impulses is known to be situated " in the left side of the heart, arch of the aorta and the carotid sinuses " and the normal method of stimulation has been shewn to be the change of blood pressure in these parts of the circulation at each beat of the heart.

During the exercise there is an increase in the sympathetic accelerator and reduction in vagus impulses. The range of acceleration is determined by the degree of activity of cardio-inhibitory centre. In athletes mild exercise results in an increased cardiac output with a slight increase in rate. Animals and human beings taking large amounts of exercise have slow hearts and the cause for the slow heart is not known. The increase in cardiac output is the result of dilatation of the vessels in active muscles, and the constriction of vessels in less active tissues. The dilatation is due to chemical and nervous influences. The cause for the chemical dilatation has been much debated. Carbon dioxide and lactic acid, changes in H-ion concentration, adenylic acid, histamine and histamine-like substances are credited with a vasodilator function. The nervous dilatation is probably sympathetic.

In describing the " capacity effects " Prof. McDowall states that with the possible exception of the voluntary muscles, the heart muscle and the brain, all the other tissues of the body provide the blood necessary for the active muscles. He refers also to the constriction of the spleen and intestine in animals, and to the constriction of vessels of the skin under emotional stress or anticipated activity. The sympathetic constriction of the vessels is due perhaps to a sensory stimulation from the outside world.

The maintenance of vascular reserve is rendered possible by the existence of the tonic dilator control of the vessels. The primary function of the control of vessels is to maintain the arterial pressure at a constant level. The reflex control may have a more important function, and in exercise or emotion increase both rate of the heart and output per beat. It may be stated that the vagus controls the range of activity of the heart and the depressor reflexes determine the quantity of blood available for the heart. The vaso-constrictor action of the sympathetic and the effect of adrenaline and the value of the other mechanisms are already referred to. Adrenaline in physiological doses constricts the vessels of the skin and splanchnic region but dilates those of the muscles which latter is perhaps due to its environment. Further adrenaline influences the depressor reflexes markedly, as it has been

found that after the effects of injection of adrenaline have passed off, vagus stimulation, effective before injection, has no action on the heart; similarly in injection of adrenaline the effects of blocking of impulses from the carotid sinus are either reduced or completely abolished.

A study of the effect of exercise and of emotion on man affords confirmative evidence of the function of the vasodilator reflexes mentioned earlier in the address. A rise in systolic blood pressure of man taking exercise on a stationary cycle, with subsequent fall below normal on the cessation of exercise, has been observed. The fall in pressure is due in part at least to a diminution of the peripheral resistance in the muscle. It has also been observed there is no change in blood pressure as a result of psychical effect of intended exercise and that of exercise and the rise in arterial pressure is therefore due to psychical effect. Since it is known from the work of Mosso, Barcroft, Florey and Florey that generalised vaso-constriction is an accompaniment of psychical effect "we must assume that the increased output of the heart is in part if not wholly the result of vaso-constriction which calls into use the reserves of blood and thus circulation is maintained in spite of the greatly increased capacity of the active muscles". It should be observed that the problem of the control of circulation of the blood is bristling with difficulties, especially since the activity of the vagus and depressor mechanisms is variable in different animals under varying experimental conditions.

A. S. R.

Psychology.

President: DR. A. W. WOLTERS.

THE PATTERNS OF EXPERIENCE.

THE Presidential Address is devoted to recording of certain reflections stimulated by contributions to the Psychology section of the previous year's session, and to a short active vindication of some of the views of the colleagues of the President. A comparatively young discipline like Psychology which has not yet acquired any great content of established fact is bound to be confronted with controversies and civil wars which need not be deplored. Controversy is the vital breath of science. A too ready loyalty to "a school" is symptomatic of a fettered mentality. Omniscience or infallibility cannot be claimed for this or that group of workers and researchers however distinguished. Opposing theories have in them elements of truth. A balanced and judicious eclecticism is thus not only reasonable but inevitable. Eclecticism *qua* cheap collection of elements from different schools or groups is valueless unless the dynamic orientation is administered to it of a personal view-point. Two papers read last year are taken as texts.

Prof. Rubin's paper on the "Ways of Seeing" makes an important contribution to the psychology of perception maintaining the thesis that perceptual cognition or awareness is shot through with suggestions of movement and direction which are not reducible to the geometry of the object. The mind contributes structural principles to its own experience. This had been emphasised before by others, but, the value of Rubin's contribution lay in experimental elaboration and demonstration of the theme. Rubin pointed out that pictures in European Art have a definite left-to-right character on which their meaning and æsthetic appeal largely depend. An exciting confirmation of Rubin's theory was afforded in the shape of a drawing of Rembrandt which proved to be an exception to Rubin's general thesis. Rembrandt's error explained by Mr. Betts as due to absorption in technique of sketch, really confirms Rubin's conclusion. This is something like *exceptio probat regulam.*

There are then, pre-established manners of seeing, and it must follow that other modalities of sense also reveal pre-established manners. The patterns of perceptual experience are dependent upon the mind, in some instances upon congenital endowment and in others upon acquired factors. Rubin suggested that the left-to-right direction of European pictures was derived from reading left-to-right script. Mr. Peake suggested that Rubin's theory may be tested in reference to cave-drawings. This is yet to be done. So far as the evidence now available goes, right-handedness is among the determinants of perceptual direction. It appears that perception can be shaped by factors extrinsic to the material experienced. The mind influenced by them is creating, is actively patterning its experience, so that in some sense and to some degree, (the limits being experimentally ascertainable) the mind makes the world it knows. If, on a view like this, no knowledge is possible of reality, as some would contend, the other contention is equally forceful that if the percipient mind merely registered the objective world there could be no psychology of perception worth the name. The researches of Katz and Thouless demonstrate that the mind sometimes deals with its material autocratically. Here Gestalt-psychology cannot be treated incidentally but admiration for the ingenious research stimulated by it cannot be witheld. To speak a little dogmatically the mind informs its sensory material making the percept consistent with certain subjective principles. The patterns of experience are latent in some sense, in the subject's mind as he confronts the world.

Perceiving is a response of the organism. It means that the distinction between cognition and conation is not ultimate. *Conation must* be fundamental because every organism must remain alive and to that end it needs to shape, and control its environment. Behaviour exhibits ordered sequence on the basis of which laws are formulated. A man's business activities show a constant pattern. Patterns are the constancies without which social life would be impossible. Instincts are examples of behaviour-patterns. These patterns are observable in virtue of which the epithet 'instinctive' is used. The character of the organism is among the causes that produce the patterns. Human behaviour patterns resemble those of animals. A pattern is latent in the organism. It exists formally. There are also patterns in acquired activities. Skill is said to produce the patterns. Skill in itself cannot be scientifically inspected but the resultant activity can. Skill is responsible for characteristic behaviour-patterns which control

environment and which lead a subject from success to success as it were. Skill is conditioned by racial and individual experience. Perception is a preparatory reaction and Rubin's 'ways of seeing' belong to the vast family of skills. It was argued in a paper read at a London Meeting (1931) that concepts are not mental entities but as outline preparations for response. Conceptual thinking is schematic preparation for response. Prof. Bartlett uses the term 'schema' for active organisation of past reactions with which new experiences are redintegrated. Characteristically redintegrated effect of experience determines responses of the subject at all moments. Racial and individual experience results in schematic preparation for future activity thereby determining the pattern of the experiencing and the pattern experienced, and these preparations or schemata are modifications of the psychological organism.

This view is illustrated in reference to social psychology and social patterns. Reference is made to Prof. T. North Whitehead's paper in which report is made of a study of a group of five girls at the same task. They had developed a social pattern on the basis of conversation, and when their seating arrangement was deliberately altered output was adversely affected. Other details of the experiment are given which demonstrate-that the developments of social patterns is due to the psychological character of individuals. A group or society exists only in virtue of the conative tendencies developed by individuals. It requires to live socially, considerable skill. Social skills are schematic preparations for adaptive responses. Society exists immanently in the minds of its members. A group pattern is the product of the behaviour schemata of the constituent members. Social patterns are exemplified in institutions and current ideas—the English Common Law for instance. There is no need ' to turn round upon the schemata ' so long as particular patterns contribute to efficient life.

Ideals and institutions express the developing patterns of society. An Ideal is just a scheme of behaviour rendered sufficiently inspectable to receive a name. The activities of the organism striving to hold its own in the universe would form the subject-matter of Psychology. The material presented to it in experience should be organised into patterns if it is to control its environment. It develops skills. These skills are called schemata. The system of a person's schemata embodies all his experience upto the present and determines the direction of his future behaviour. The patterns are formed by them though not independently of objective conditions. "Ways of seeing" and "ways of living" would then be species of a common psychological genus. Thus in conclusion experience in the fullest sense of the term is formed in a complex of patterns interlacing and revealing a heirarchy of increasing generality. Or Psychology is a study of all the detailed embroideries upon behaviour patterns the formula of which runs—He was born, strove to master his world for his own safety; he mated, fought for his offspring and died. There is really no opposition between Individual Psychology and Social Psychology.

R. NAGA RAJA SARMA.

Botany.

President: J. RAMSBOLTOM, O.B.E.

THE USES OF FUNGI.

(1) *Edible Fungi.*—The common edible mushrooms are probably the best known of all the fungi and they are cultivated on a large scale in Europe and America. Formerly it was believed that they occurred spontaneously on horse dung. Nowadays the spawn is produced commercially by scientific methods by inoculation with either the spores of the fungus or the flesh of the stipe. The annual production of mushrooms in America now exceeds 17,000,000 lb.

The Japanese and the Chinese are great consumers of fungi. Several species of *Cortinellus* are cultivated widely in Japan for the purpose. About £100,000 worth of the material is exported annually from Japan. "Kah-peh-soon", which is much valued as food by the Chinese in Formosa is the hypertrophied portion of the shoot of *Zizania aquatica* infected with *Ustilago esculenta*. Species of edible *Volvaria* are also cultivated in the tropics. The highly esteemed truffles and morels of Europe and America are fungi belonging to the family *Tuberaceæ*.

(2) *Poisonous Fungi.*—It is also well known that some of the common fungi are poisonous. The French criminal, Girard, who was executed in 1918, used *Amanita phalloides* for poisoning his victims. In the religious rites of certain Siberian tribes *Amanita* is used for its intoxicating effects. It is reported that the Watusi tribes of Victoria Nyanza, for acts of vengeance, used to remove the lungs of persons who had recently died of pneumomycosis, dried and powdered them and administered this powder in banana beer. The fungus always survives the treatment.

(3) *Articles of Toilet.*—Hottentot ladies use the spores of *Podaxis carcinomalis*, as a face powder. The black spores of *Ustilago esculenta* are used in Japan for blackening the eye-brows. Spores of *Tolyposporium* were found mixed with rice flour as face powder in the "vanity case" of "An European Mummy" from a Roman cemetery near Budapest.

(4) *Ornamentation of Wood Work.*—The famous green wood of Tunbridge ware is only oak or birch containing the mycelium of *Chlorosplenium æruginosum* which imparts the green colour to wood. The black lines of some decorative wood are due to infection by *Armillaria mellea* or *Ustilina vulgaris*. The colour of the much valued "brown oak" is due to infection with *Fistulina hepatica*.

(5) *Fodder for the Cattle.*—On the Chiloe Island and in Eastern Patagonia the wood of various trees is converted into palatable fodder by the action of *Mucor racemosus* in conjunction with bacteria. Inoculation with *Aspergillus fumigatus* raises the assimilable protein content of straw.

(6) *Medicinal.*—The ergot of rye (*Claviceps purpurea*) is mentioned in the British Pharmacopæa. The medicinal properties of Agarics like *Polyporus officinalis* have been recorded by classical writers. Yeast is still used for various ailments and is incorporated in many patent medicines. *Cordyceps sinensis* which parasitises the caterpillar is widely used as medicine by the natives of China and Tibet.

(7) *Horticultural.*—The part played by the mycorrhiza of fungi in the cultivation of orchids is

now well known to horticulturists. The difficulty in germinating the minute orchid seeds had baffled the horticulturists for a very long time. Noel Bernard however astounded the botanical world by extracting a fungus from the roots of *Neottia* (the bird nest orchid) and by sowing the seed with it obtained abundant germination. This method is now used commercially. Like the orchids many of the forest trees have fungal mycorrhiza in their roots which help the passage of food into the tree roots. Sylviculturists are now investigating the problem of artificially infecting seedlings with appropriate fungi.

(8) *Food and Drinks.*—The use of fungi in bringing about desirable changes in food and drink has been known from very early times. At present this is done under controlled conditions and fungi are becoming increasingly important in the industrial application of fermentation activities. "The chemical conversions performed by these organisms rather resemble witchcraft than chemistry." In bread-making the use of leaven which contains the yeast is very well known. Nowadays pure culture strains of compressed yeast are used in bread-making.

Yeasts bring about the fermentation of fruit juices in the manufacture of cider and wines. *Botrytis cinerea* is used for infecting grapes to produce the Sauterne wines with higher alcohol contents. Beer brewing is now a well-known art. Almost every nation has its ancient fermented drink like the Kvass of Russia and a few others.

Certain bacteria are also used in conjunction with yeast for bringing about fermentation in beverages like the Mexican Tibi. Chinese curd, To-fu, is made from soybean milk fermented with mould. Food products and beverages amounting to a value of £40,000,000 are manufactured annually in Japan alone by the fermentation activities of fungi. The Chinese "Red rice" is produced by infection with *Monascus purpureus.* The part played by species of *Penicillium* in the ripening and flavouring of cheese is only too well known.

(9) *Fuel.*—In order to economise the use of coal, the supply of which is not likely to last very long, power alcohol obtained from plant materials by fermentation with yeast may have to be substituted.

(10) *Industrial.*—The production of dextro and lævo tartaric acid by Pasteur by the action of *Penicillium glaucum* is probably the first step in the use of fungi to industry. Van Tieghan isolated gallic acid from tannin by fermentation with *Aspergillus niger.* During the War, glycerine for nitroglycerine, was manufactured first by the Germans and then by the Americans by the fermentation of sugar with yeast. Commercial diastase is manufactured from *Aspergillus flavus-Oryzæ.* Oxalic and citric acids are produced as a result of fermentation by many fungi. An American firm is stated to maintain nine acres of mycelium of *Aspergillus niger* to supply calcium citrate for the American cheese industry. Gluconic acid is another fermentation product of *A. niger* and several species of *Penicillium.* Anthroquinone pigments which are so important in dyeing are produced by certain species of *Helminthosporium.* The antispetic, penicillin, is produced from *Penicillium notatum* and *Fusarium* sp. produce large quantities of alcohol from glucose. Ergosterol has been synthesised by the action of yeasts and moulds. Marmite is an extract prepared by autolysis from fresh brewers' yeast. The Russians after the War utilised yeast for the production of fat. The manufacture of acetone with *Mucor Roxii* is one of the romances of modern microbiology.

The above are only just a few of the products obtained with the help of fungi. A vast field for useful researches is thus opened out where the taxonomist, chemist and physiologist can work profitably together for the good of humanity.

K. C. M.

Educational Science.

President : SIR RICHARD LIVINGSTONE, M.A., HON.D.LITT., HON.LL.D.

THE FUTURE OF EDUCATION.

" To cease education at 14 is as unnatural as to die at 14. The one is physical, the other is intellectual death."

THIS is the main thesis of the address which expounds the need for a strong and efficient system of continuation and adult schools for the diffusion of the essential elements of culture in order to equip the democracy in the intelligent participation of public problems and in the maintenance of a reasonably high standard of useful and enlightened life. So far as education is concerned the primary duty of the State is to provide for every individual opportunities to make a livelihood and to function as a citizen and to become the " beauty of the world". In endeavouring to achieve these three-fold objects, education is obviously limited by its material, and encounters difficulties in the accomplishment of its goal of the making of human beings. If this is the supreme aim of education, then it follows that all men and women, irrespective of the class to which they belong, must have a cultural training without prejudice to the technical courses which the majority may find it profitable to pursue. Men differ in degree but not in kind, and if the electorate is incapable of appreciating the great historical movements or the wealth and variety of the human spirit, then its stability becomes precarious, and its political and spiritual life, impoverished. Perhaps humanistic studies might preserve the democracy from such a disaster.

Education in its different branches,—University, Secondary, Technical and Elementary,—has solved some of the problems with which it was confronted, but we have not been able yet to define to our own mind what we wish education to do for us, and to ask whether it is doing it and, if not, why not. The examination papers reveal the great gaps in our national system of education and the task of improvement and elaboration necessary for the more efficient use of its tools for obtaining a deeper insight into its purpose and significance. There is a fairly satisfactory provision for the minority who attend secondary school and university, but we have shown the rest either a glimpse of the vast treasures of knowledge or disinherited them from the purest and highest intellectual pleasures. The question of the working-man and his leisure affects the future of civilisation. Will he enrich it ? or will he devote his leisure to the films and the dog races ? Fifty years ago the employment of leisure was no problem for any but the rich

who mostly wasted it, but to-day it is becoming a common place of education. The task of the future is for us to ask ourselves how the intellectual and spiritual life of the nation will fare, when the greater part of its people leave school at the age of 14 and are thrown straight into the deeper waters of life. In this matter the attitude of the State has been as complacent and unthinking, if not as disastrous and cruel, as that of the earlier generation who acquisced in social inequalities which seem incredible to us. The task of the future is clear, *viz.*, to deal with this great educational problem of the boys and girls who leave school at 14.

One of the fundamental principles of education is that its fruitfulness depends on experience of life, though this may not apply to the physical sciences with the same force as it does to the humanistic subjects. It is necessary to know life itself, to have seen something of human nature, before either achievement or understanding in these fields is possible, and it is obvious that a fourteen or fifteen-year-old is not sufficiently adult to grasp the value and significance of history, economics, sociology, politics and philosophy. What does a pupil of the age of 14, 15, 16, 17 get from the study of history, for instance which in secondary schools is a favourite subject for specialisation? They are well taught and interested in the subject and they can reproduce the best books. "They have the appearance of wisdom but not its reality" as Plato said of these who absorb information from books without digesting it.

The practical conclusion is that an education which ends at the age of 14 is no education at all. Money spent on secondary education is not wasted if it prepares the pupil to go on to something else. The fact is that a vast majority go to nothing else, after putting their feet on the first step of the ladder of knowledge. But the defects of the present system will not be remedied by raising the school age to 15 or even to 16. The pupil will be still unripe for the studies without which an intelligent democracy cannot be created. Raising the school-leaving age may help some of our difficulties. Its value is perhaps moral and economic rather than intellectual. No body who has seen the results of compulsory education to the age of 16 in the U.S.A. will be under the delusion that it produces an educated nation. If, however, the raising of the school-leaving age is preparatory to an education continued into the adult years, well and good; if not it will leave the problem still unsolved.

The solution of this problem will not be found in the secondary education about which this age is over-credulous. The hard fight for its development has caused us to exaggerate what it can do. Secondary education is only one part of the great picture; and we need to stand back a little and see the canvas as a whole. Economic reasons suggest that the earlier years of life should be given to secondary education which is addressed to pupils whose intellectual faculty, except that of memory and imagination, is not fully developed, and who cannot have a full perception of the purpose and value of education. In every point except the economic one adult education has the advantage over secondary education. It is given to students who desire it, and who have the mental development to receive it; whereas secondary education is given to pupils whose faculties are not fully developed, and who have not seen enough of life to value and interpret it. It should be realised that the education of the masses can never be achieved through secondary education. The ideal plan might be for everyone to leave school at 15, and pass into a system where a part of the week is allotted to school, part to earning the living in some practical occupation. Unless we establish a compulsory part-time continuation system which will carry the pupils on to 18, the education of the earlier years of the youth of the nation will still be largely wasted. If the first step to retain those who leave school before the age of 18, under some educational control is secured, it will be easy to take them to the threshold of adult education, where the solution of the problem of educating the democracy must be found. The experience of Denmark is encouraging. The Danish Folk High School is attended by 30 per cent. of the small farmer and working-class population, voluntarily and at their own expense, for five months, and the education is humanistic in the sense that it is neither technical nor utilitarian. The main point is to urge the indispensability of adult education, to review what it has already done in order to harmonise, develop and complete it.

Agriculture.

President : PROF. J. HENDRICK.

SOIL SCIENCE IN THE TWENTIETH CENTURY.

THIS is perhaps the first time that a Presidential Address deals specifically with soil science as a fundamental subject, though some of its aspects have received attention in the past as from the nature of things such reference was unavoidable when dealing with the various different problems of crop production which have formed the subject of those addresses. It was only in the last century that the vast store of practical knowledge built up solely through experience and handed down by tradition began to be succeeded by a knowledge of the science, advance in chemistry and geology being chiefly responsible. In Great Britain the provision for agricultural research was for a long time meagre, Rothamstead, Cirencester and Edinborough being about the only centres of study and research. A forward move was possible only with the Development Commission of 1910, but the easier and more obvious problems of manuring and field experiments claimed first attention and soil studies were stagnant; such as were taken up were mainly from the point of view of its fertility and usefulness as a medium for crop production and not in any of its fundamental aspects. British views on soils remained rather narrow and insular, the soils of S. E. England being regarded as the types, notwithstanding the variety of location and climate even in this small island which have given rise to a corresponding variety of soil types. In contrast with Great Britain the countries of America and Russia embrace vast areas extending through wide ranges of latitude and climate, with great variations in geological conditions and with soils derived from many kinds of rock formations. Arid and alkaline soils were also a special group. Soil studies there were more comprehensive accordingly

but British thought could be influenced only by the studies of American workers, the barrier of language rendering Russian work inaccessible and therefore unknown in Britain for a long time. No better picture of the gradual growth of recognition in Great Britain of the Russian school and its work can be found than the bibliography appended to the different editions of Sir John Russels' book *Soil Conditions and Plant Growth* which devotes adequate attention to the work of this school only in its latest or sixth edition of the year 1932. It was through the agency of the International Society of Soil Science which was founded in Rome in 1924 that publicity was afforded to this new knowledge of soil science, although this itself grew out of international conferences on Agrogeology held before and after the Great War at Budapest, Stockholm, Prague and Rome, which last led to the formation of the International Society and later to an International Congress at Washington in the year 1927. It was at this congress which was attended by a large contingent of British, American and Russian workers that the new views of the Russian school were fully explained, demonstrated and discussed, making it to many a new education in soil science. Other agencies for publicity have not been wanting and the journals *Soil Research*, *Soil Science* and the *Proceedings of the International Society* are doing much to make known widely these new movements.

The historical background having thus been described, these new views of the Russian school of soil science may now be discussed. In the first place, the Russian school treats the soil as an independent natural body worthy of study for its own sake and not merely as a medium for plant growth or as subsidiary to chemistry, geology or other sciences, according it a new and separate status under the name of Pedology. Secondly, the Russians regard climate the most important among pedogenic factors and hold that its nature is not determined by its geological origin. They have shown that very different soils may be formed from the same rock in different climates and on the other hand similar soils may be produced from different rocks under similar climatic conditions; that, for example, the granitic soil produced in the cold humid climate of Scotland would have been different if produced in the hot humid climate of Africa and would be still more different if produced in a hot arid climate in Asia. The climatic zones indeed form the basis of classification, so much so that one can detect a tendency to go too far in excluding geological origin as an important factor. A third feature of the new science is the study of the "soil profile" and of the "horizons" which go to make it up. The virgin soil unchanged by human agency is what is required for this purpose, which is a condition impossible to satisfy with soils in many of the most important parts of the world and which would therefore necessitate some modification in the methods. The profiles are also sought to be classified as mature and immature; but the soil-forming processes greatly vary in their duration, some requiring periods of geological time while others can take place in a few centuries or even in a few years. The granitic soils of Scotland are examples of the former and factors which produce changes in the organic matter content of soils come under the latter category. Much further study is therefore needed before these can be properly accounted for and a satisfactory system of soil classification established.

The importance of soil moisture and rainfall as climatic factors in soil formation is recognised especially as they may be influenced by the humidity, temperature, topography and the amount and distribution of the rainfall itself. The closely relevant study of soil drainage and of the changes taking place in the composition of the soil and the soil water during the process has not received the attention that it deserves in this connection. This is owing probably to the difficulty of constructing drain gauges which will deal with soil in its natural *in situ* condition and not with soil moved and filled into the cisterns. The latter are only of limited use in their application to actual field conditions. Reference may however be made to those in Rothamstead and those constructed by the author at Craibstone near Aberdeen which are of the type dealing with the undisturbed soil.

A notable advance in soil science is our knowledge of soil colloids and base exchange. K. K. Gedroiz the Russian worker, van Bemmelen, Dr. Hissink and G. Wiegner are noted names in this field and it is from their work that we know now that base exchange is a colloid phenomenon and that both mineral and organic colloids possess this property and that it is not the former alone which was concerned in the process as was supposed at one time. This advance has also enabled us to estimate the degree and intensity of soil acidity and alkalinity as well as to understand the exact rôle of lime in its capacity as an exchangeable base. The structure of clay, the nature of its base exchange capacity and the differences found therein have received considerable elucidation by the X-ray method which has revealed the presence of a lattice structure and of several different minerals showing at least two different types of lattice structure. X-ray methods are also clearing up the nature of humus and are furnishing evidence of its possessing a complex molecular structure.

Soil science is making steady progress in these and along other lines of research and in the British Isles soil problems are now being studied from many angles in the various research stations, colleges and universities. The British attitude towards soil science however is still somewhat utilitarian, in that it declines to dissociate soil study from its practical application, with the complete detachment of the Russians; one is primarily interested in the soil on account of its plant-growing capacity. Increased production of the products of the soil is a blessing and not a curse and a strong plea may be put in for the harnessing of science for increasing production, despite the cry of overproduction. As long as there is want and underfeeding in this world there cannot be overproduction.

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Public Benefactions and Science.

LORD NUFFIELD'S munificent gifts to the University of Oxford are worthy of admiration and imitation. They must have a strong appeal to the more enlightened and wealthy communities in India, and hopes might be entertained that the Indian Universities and other research institutes would likewise benefit by the philanthropic and patriotic instincts of the rich landed proprietors and industrial magnates in this country. The conservative temperament of the Indian mind has not understood the full significance of the somewhat cryptic saying, "cast thy bread upon the waters," for generally it fears, that instead of finding it after many days, it may be totally lost. The sage's assurance that it would return in increasing abundance ought to inspire public confidence. No thoughts of personal gain underlie public benefactions, which are made solely with the object of assisting the work of self-dedicated scientists, whose labours result in the benefit of our own generation and the generations yet unborn. Practically in every instance, material prosperity is absolutely dependent upon the patient researches of those who seek for no personal reward, and whose work at the time was thought by men of affairs to be of no consequence. It must not be forgotten that the foundations of our greatest present-day advances were laid by scientists, and the increasing returns, which men of business reap, have originated in work inspired by no thought of personal gain. Of all the human activities, perhaps the one thing that cannot be overproduced is scientific research, and we can conceive of no time and no situation when industry cannot utilise it. Nothing can be more clear than the fact that the substitution in economics of the law of increasing returns in the place of its old antonym, demands the continuous and increasing support of scientific research, which is the foundation of progress. The country which hesitates to strengthen and extend research in the domain of pure science

voluntarily renounces its claim to independent economic existence, content to seek its prosperity in the foot-paths and by-lanes of international progress.

Generally speaking, India looks at public and private philanthropy from the spiritual standpoint, and she treats mechanical civilisation as synonymous with materialism. Further, the unhappy association of science in developing the technique of modern wars has tended to diminish public faith in the benefits conferred by it on humanity. Even enlightened persons are apt to interpret the achievements of science in terms of material benefits, because they are more tangible, and their more enduring spiritual message escapes attention probably because their reality is less manifest. Our knowledge of Nature has opened out a new outlook on the significance of life, and the old superstitious beliefs and mystical rites have disappeared in proportion to the appreciation of the reasonableness and orderliness of the fundamental laws of nature. In emancipating the human mind from mediæval mysticism, science has also provided spiritual opportunities all along its progress. Science, while it acquires increasing power over Nature, places all its resources for the service of man. Science is non-moral. It shows the path of increasing human health and comfort. It also provides those who would erect a superstructure of industrial application with the increasing means of augmenting national prosperity. The researches in the field of chemico-medical sciences promise to prolong life and promote its efficiency. The recent advances in the domain of economics and sociology have acquired a body of knowledge which seems capable of fertilising society with a fresh and vivid life-giving stream of benefits. As a result of researches in basic sciences, rural occupations have opened out numerous problems upon whose satisfactory solution depend the happiness and contentment of the millions of the village population, whose present standard of living, sanitation and indebtedness must be a reproach to civilisation.

Scientific research is generally considered as a luxury by government and the public, and not as a fundamental necessity for making life better, cleaner and richer. It postulates the new law of increasing returns, which can be reaped only when its structure is strengthened and extended. Public opinion in India is still slow to recognise that the frontiers of science are unlimited and that industry and the nation owe to its efforts in extending the field for cultivation, continued and unstinted support. Industry was the first to benefit by the application of scientific results, but we have not utilised the new knowledge of a far-reaching and fundamental character in promoting our means to health and our economic and social orders. Scientific discoveries are an investment, and the public have not yet placed this intellectual property on the status of a national asset. If a fraction of the public enthusiasm and private money now expended on activities of a general and doubtful import, could be engaged in support of the Universities and research institutes in India, and if this support is not intermittent and wasteful, this country within a generation may be reasonably expected to achieve sufficient progress to make up for all its arrears. Encouragement of scientific work in India has not yet acquired the status of public obligation of sound management in the minds of her wealthy people, who too often rely on government for financial support. To the building of national greatness, the contribution of government is small, and its foundation and edifice are the work of discriminating philanthropists.

The political power with which India is shortly to be invested for the management of her affairs involves an imperative obligation on the part of her wealthy communities to recognise that in this country the rapidity with which industrial development and economic independence could be achieved must be proportional to the encouragement accorded to science. As a practical measure for sustained national progress, we believe that a fairly comprehensive plan should be immediately adopted for encouraging capital to enter the field of new scientific developments. Where scientific institutions receive private endowments we can confidently look forward to stimulating contributions not only of a theoretical value, but also to those which would not exclude social problems and their constructive integration, but emphasise them.

From Vitamin C to Vitamin P.

By Prof. A. Szent-Györgyi.

(Professor of Organic and Medical Chemistry, University of Szeged, Hungary.)

MY first real interest in Biochemistry was in the function of the adrenal cortext. At that time we only knew, that this internal secretory gland was essential for life. Without this organ life failed. Furthermore, we knew, that patients, suffering from the deficiency of the gland, turned brown, before dying. Bananas and pears do the same. The pigmentation of dying vegetable tissues has been shown by Palladin, the great Russian plant biochemist, to be due to a disturbance in oxidation-reduction equilibrium. So I hoped, oxidation-reduction processes will explain to me the function of the adrenal cortex. But we knew too little about oxidation systems too. So I set out to study first animal, and later vegetable, oxidation systems. The first systems analysed, that of succinic oxidation in muscle, and the polyphenoloxidase in potatoes gave me no clue, but while analysing the peroxydase systems in turnips, I found there was a substance present, which was capable of inhibiting the formation of melanoid pigments. This substance was a strong reducing agent, which reduced immediately oxidised phenols, before they could undergo further modification and form pigments. I isolated the substance and made its first approximate analysis, establishing its empirical formula and some of its more important characteristics.

It was a great excitement, when I found the same substance in relatively big quantities in the adrenal cortex.

The "isolation" and "identification" of this substance was not quite as easy, as writing these words down. It was not a simple matter and it needed not only involved technical equipment but also money and in the laboratory of the Physiological Institute of Groningen (Holland), where I was working at that time, none was available. Further researches on the isolation and identification were made possible by a friendly invitation by Professor F. G. Hopkins to join him at Cambridge, and by a generous grant from the Rockefeller Foundation.

Having established the main characteristics of this fascinating new substance I wanted to know more about it, especially its exact steric configuration, before attacking the problem of its biological activity. The trouble was however, that I had too little of it, only a few milligrams and I could make no more, because, of the labile nature of the substance. The only suitable material for large-scale preparations was the adrenal gland, which was not available in Europe in sufficient quantity. Prof. A. Krogh of Copenhagen tried to help me by sending me adrenal glands from Denmark to Cambridge by air. The material, however, deteriorated during transit and was therefore, useless.

Once more, international co-operation rendered fresh progress possible. Prof. E. C. Kendall, of the Mayo Foundation (Rochester, Minn, U.S.A.), invited me to Rochester and the rich resources of the Mayo Foundation together with the large quantity of material of the big American slaughter houses became available. The glands were packed in dry ice and shipped in this hard frozen condition to Rochester where the material was worked up; I was able to prepare as much as 25 g. of the substance. One exciting experience I had, was a clinical trial on Addison patients with adrenal insufficiency. The patients failed to get better, but they bleached out!

Returning from the States I shared my substance with Professor Haworth at Birmingham, who was deeply interested in it. His long-standing experience with carbohydrates, enabled him to investigate the steric configuration of the molecule. The substance unfortunately proved to be insufficient for the work and there was no chance of preparing it again.

After settling down to a more quiet life in my own country, in Szeged, Hungary, I found an opportunity, to put to the test an old suspicion of mine, (for investigating which my earlier roaming life was unsuited): whether the substance, which I had in my hands for five years, was not identical with the long sought Vitamin C. I started the work in collaboration with an young American, Svirbely, in the autumn of 1932. In November, we had the first definite answer. The animals treated with our substance, which we used to call "Hexuronic acid" all lived, while the controls all died. Owing, however, to defective diet (we had difficulty in securing milk powder), the weight curves were not satisfactory. So we repeated the whole experiment, before we

published our result in March of the next year. Meanwhile, also King and Waugh at Pittsburg isolated from lemon juice, a crystalline substance which was antiscorbutically active and which resembled our preparation of hexuronic acid. Also Tillmans in Germany found at about the same time, a close parallel between the reducing power and vitamin content of plant juices, which made the identity of hexuronic acid and Vitamin C probable.

Our substance was thus, according to its newly discovered activity, rebaptised now, and called "Ascorbic acid". By its vitamin nature the substance acquired increased importance and it was the more regrettable to have none of it. This difficulty was solved by an unforeseen discovery.

Szeged, the city in which my Laboratory is situated, lies in the middle of the Hungarian paprica—red pepper, *Capsicum anuum*—fields. I once tested paprica for its Vitamin C content and found it a rich storehouse of Vitamin C. Large-scale preparation gave good yields and in two consecutive years I could prepare about 4 kg. of ascorbic acid, providing all laboratories of the world which were wanting to work on this substance with ample material. This work was not without results. Professor Haworth at Birmingham soon established the steric configuration of the substance and its synthesis was effected both by Reichstein at Zurich and by Haworth.

In this way the most mysterious vitamin, which so long resisted analysis, succumbed to laboratory investigation. At present, it is produced synthetically on a big scale at a very low price, so that it is available for all those who are in need of it; and all this in the incredibly short time of hardly two years. This is what international collaboration and understanding can do.

Further research showed ascorbic acid to be an essential part of our diet. I myself went back to my old line of research, *viz.*, oxidation, which led me to Vitamin C. I forgot ascorbic acid and the ascorbic acid people forgot me.

Only in the last months have old reminiscences begun to awake again. As I mentioned at the beginning, I was led to the discovery of ascorbic acid by the analysis of the peroxydase system. At that time I also found, that peroxydase + peroxide oxidised ascorbic acid reversibly. This reaction occurred only, if there was an aromatic substance present, which induced the reaction. Peroxydase had no direct effect on ascorbic acid; it however oxidised aromatic substances to quinols, which, in their turn, oxidised ascorbic acid. I wondered which aromatic substance was playing this rôle in the plant, especially in lemons. I was led to a very peculiar new substance, which seemed to belong to the widely spread group of vegetable benzo-pyran dyes, the flavons. I suspected that this substance might have a vitamin nature too. Only there was no animal test for its study. So I put the substance aside in the hope, that at some later date I might find one such. Now nature seems to have given us a suitable test in the form of certain human pathological conditions, such as the Hæmorrhagic Diathesis (vascular type). My friend, St. Rusznyák, Professor of Medicine, has told me, that he had some very good cures of such conditions with paprika, but the effect was not due to the ascorbic acid present. To what was it due then? The same effects could be obtained with lemon juice. We set out to investigate the question and to find the substance responsible for this activity. And in the end we found it. It was nothing else than my old friend, the flavone, carrying the reaction between peroxydase and ascorbic acid. The crystals of the substance had the same therapeutic effect, as the whole pepper. They cured in a striking way disorders of the permeability of the capillary wall. So we gave the name "Vitamin P," to this flavone and we are hopeful, that in its ability, to reduce human suffering, this new substance will be no less important than ascorbic acid.

If the vitamin character of this substance be firmly established, this will also mean that the great group of vegetable dyes, the flavones, which seem to play such an important rôle in plant biochemistry, also function in the animal organism. So the substance will form a new chemical link between plant and animal physiology and may bear new evidence for the big chemical unity of living matter.

The researches on ascorbic acid described in this article serve to bring out certain features characteristic of modern research. Thus, work on some fundamental problems yields results quite unsought and opens up vistas quite unsuspected; rapid advance is dependent on international collaboration and in modern research investigations of micro-quantities of substances should proceed side by side with the preparation of materials on a large scale using tons of raw material,

Researches on Galaxies at the Harvard Observatory.

By (Miss) Jenka Mohr.

(*Harvard College Observatory, Cambridge, Massachusetts, U.S.A.*)

AMONG the many attempts of mankind to survey the universe, astronomy is almost unique in its combination of sweeping fields and sharp limitations. It reaches further into space than any other science; and it finds the demands of space and time more binding. Vast distances and dimensions are involved; processes are exceedingly slow, in terms familiar to man. The result is a constant challenge to man's ingenuity to devise techniques and to interpret observations.

Some of the problems that confront us when we examine our own galaxy, the Milky Way, also need solving when we study the distant universes that make up the rest of the Cosmos. Questions of size and structure, of dynamical conditions, are the same. There is the same analysis of the population of our own and other galaxies near enough to be examined in detail—stars and star clusters, gaseous nebulæ, stars that vary in light. (It may be pointed out that the terms "galaxy" and "nebula" are frequently used interchangeably to mean a great organization of stars. But since the word "nebula" is also used for the bright or dark clouds of gas or dust particles which are characteristic elements in many galaxies, we shall use the term "galaxy" mainly in the following account.)

Because we are involved in the midst of the Milky Way system, and at a great distance from all the others, there are many problems that arise only when we look beyond the Home Galaxy. The most essential problems deal with the general structure of the Metagalaxy, as the system of all such organisations of stars is called. What is the nature of the Cosmos? How many, and of what kinds, are the elements it comprises, and how are they disposed throughout space and time?

Again, we can study some of the distant galaxies to greater advantage than we can examine our own system. It is extremely difficult to obtain information about the Milky Way as a whole. We are not sure whether it is a single spiral or a group of smaller galaxies or an irregular system. The presence of absorption, the crowding of stars, the difficulties of obtaining perspective, throw us into confusion and uncertainty. But the other galaxies are observable from the outside. In some of the nearer ones, such as the Andromeda Nebula and the Magellanic Clouds, we can even study individual stars and clusters and gaseous nebulæ. Thus we are much more likely to learn what a typical galaxy is like by leaving the Milky Way, and exploring the neighbouring systems.

(1) One of the most fruitful sources of information about the structure and contents of an individual galaxy is the pair of systems lying close to the Milky Way, and probably functioning as its satellites. The Large and the Small Magellanic Clouds are much closer to us than any other external system—they are not a hundred thousand light years distant. Even a small telescope reveals something of their nature. Larger instruments show plainly many thousands of their stars, and other conspicuous features. At the Harvard Observatory a number of studies have been directed to the analysis of the Clouds as typical galaxies. Some of them are here briefly mentioned:

(*a*) The Clouds have been the source of considerable material on variable stars, which furnish the yardstick for measuring great distances. Over three thousand of these fluctuating stars are now known in the two Magellanic Clouds.

(*b*) A number of globular clusters found on the borders of each of the Clouds in the past two years have increased their recognised diameters considerably. The Large Cloud is now known to be about eighteen thousand light years across, and the Small Cloud about twelve thousand.

(*c*) Spectrographs of the brightest stars in the two Clouds are being taken with the 60-inch telescope. They will yield definite values of the radial velocities, and possibly information on the rotations of the Clouds—valuable material for the study of the dynamics of a galaxy.

(2) A recently developed type of analysis which is being extensively used at the Harvard Observatory on the brighter galaxies is the method of densitometer measures. Photo-tracings across the images of nebulæ are made which indicate the distribution of intensity of light. Thus two phenomena can be examined with considerable accuracy —the diameter of the object and the changes in density of luminous matter across its

surface. Diameters have been measured on many photographs, and the results show that the galaxies are very much larger than they had been believed to be. The outer extensions are much fainter than the central regions, and therefore not visible to the eye in examining photographic plates. The results are of inestimable importance in dealing with many problems of galactic structure —primarily, for example, the heretofore unexplained disparity between the two principal types of galaxies, spiral and spheroidal objects. The latter, an almost featureless type of galaxy, had been estimated as much smaller than the spiral form ; but the densitometer measures indicate that the diameters of the spheroidals are increased by the faint extensions more than are those of the spirals. Thus an apparent discrepancy in the workings of nature has been to a large extent removed by our increased knowledge of the phenomena.

(3) The distribution of the galaxies on the celestial sphere and their distribution through volumes of space are of primary importance in a study of the Metagalaxy. In order to get complete knowledge of such distribution, large regions of the sky should be examined, so that the accidents attendant on small samplings will be obviated. For this purpose the Harvard Observatory is using at both the Northern and the Southern Stations telescopes which combine a fairly large field with space-penetrating power. On a single photograph there is covered an area of thirty-five square degrees of the sky ; and nebulæ to the eighteenth magnitude—which means, roughly, to a distance of seventy five million light years—can be recorded in an exposure of three hours. Thus, with a reasonably small number of photographs taken on adjoining regions, several hundreds of square degrees are examined as a unit.

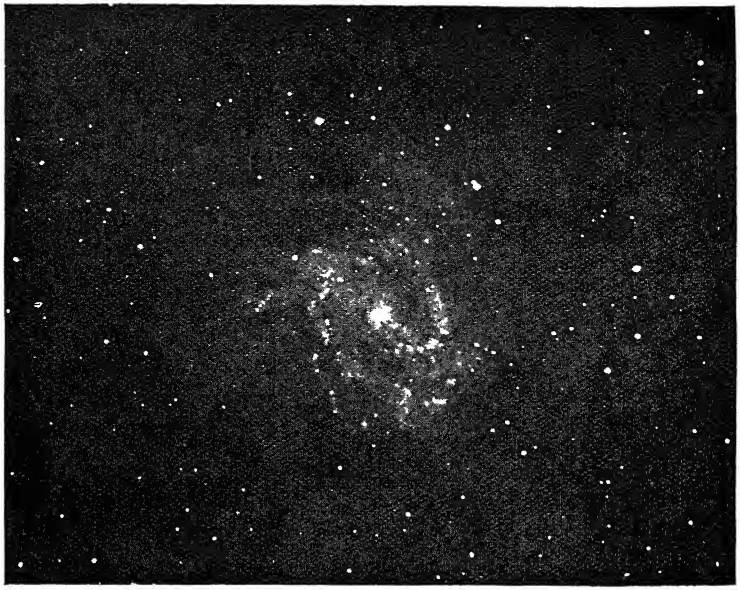
The Harvard survey of galaxies to the eighteenth magnitude has so far revealed on photographic plates some hundred thousand previously unknown galaxies, in both the southern and the northern skies. One significant fact that appears is the unevenness of their distribution. Although in many regions they appear with average frequency, in others they are surprisingly scarce ; and in still others, more surprising, there are very great concentrations. In the south, for instance, in the neighbourhood of the constellation Horologium, is a very extensive area of extraordinary richness. Here the galaxies seem to form a great stream, or cloud, many times more dense than the average. Within this Metagalactic Cloud of universes are several small spots of extreme density—spots in which the frequency is a hundred times the normal. Such clusters of galaxies are found scattered over the sky. They cover, to be sure, only a small portion of the entire sphere ; but no description of the Universe, or theory about it, can be complete that does not take into consideration these irregularities in the cosmic scheme.

(4) Clusters of galaxies are of interest not only for the rôle they play in the structure of the Metagalaxy. They also provide an opportunity for the study of relative sizes and brightnesses of individual members. All objects within a cluster may be considered as being at the same distance from us. Thus the variations in diameter and brightness can be taken as absolute differences. A study of twenty-five groups of galaxies, ranging in population from less than a dozen to several hundred, has been published by Dr. Shapley. About a score of clusters of galaxies discovered on Harvard plates are as yet unpublished. A programme is now being carried on at the Southern Station for the analysis of some of these groups with the 60-inch reflector which will yield large-scale photographs for detailed study of their members. It will also bring more complete knowledge about the numbers and magnitudes of individuals in the clusters.

(5) Still another aspect of the studies of galaxies at Harvard, while being a part of the attack on the outer Cosmos, has a direct bearing also on the analysis of our Milky Way system. This is the examination of regions lying close to the plane of the Milky Way which are rich in external galaxies. The heavy obscuring material in the central plane of the Milky Way has a two-fold effect. It hides the distant galaxies in the line of sight, and also makes it extremely difficult to measure the Milky Way itself. Stars near the centre of our system are dimmed by this nebulosity ; and therefore when the attempt is made to judge their distances by using measures of their apparent brightness, the results are false. For the absorption makes the stars seem fainter, and thus more distant, than they really are. Any measurement of the size of our galaxy must be corrected for the effect of the interpenetrating material among the Milky Way stars.

Dr. Shapley has pointed out that in places along the plane of the Milky Way where the

obscuring material is very thin, or even absent, there is little or nothing to hide the systems lying beyond. On a number of plates covering these areas galaxies have been found in normal abundance, as they would be in high latitudes where the obscuration does not occur. Dr. Shapley has used the presence in these low-lying regions of numerous galaxies as an indication of freedom from obscuring matter in our own system. He has studied variable stars in these areas in the Milky Way, which he can use safely as distance-indicators, without fear of false estimates of their brightness. The small amount of obscuration that may occur can be easily corrected for. In one region almost directly in the line to the center of the Milky Way he has found such freedom, and a study of periodic variables discovered there has shown more than a hundred stars which must lie far beyond the center itself. This is the first certain penetration into the far side of the Milky Way, and stars are now known which are further beyond the center than we are on this side of it. The research is of great importance, both in furthering our knowledge of the size of the Home Galaxy and in analysing more exactly than heretofore the structure of the dark material within it.



An open spiral, showing spiral arms, condensations of stars, and obscuring material among the arms.

N. G. C. 5236 (Messier 83).

Position : R. A. = $13^h\ 34^m{\cdot}3$, Dec. = $-29°\ 57'$.

(This picture was taken with the 60-inch reflector of the Harvard Observatory at the Southern Station, Bloemfontein, South Africa, by Dr. J. S. Paraskevopoulos.)

The studies listed above represent some of the explorations that are designed to give a consistent and detailed picture of the Metagalaxy. Limitations of space have made it necessary to omit discussion of other allied programs now being carried on at Harvard. There is, for instance, a study supplementing the earlier work on the galaxies brighter than the thirteenth magnitude over the entire sky. The new work goes to the fifteenth magnitude, and thus augments knowledge of the "inner Metagalaxy". There is also the investigation of variable stars in our own system in high latitudes, which outlines the Milky Way in its minor diameter. Such problems necessarily entail a great deal of laborious routine, and can bring final results only after some years of continued research.

The past decade or two have seen the opening of many doors into the outer world. The present time and the coming decades will bring observational material by which we can fill out the picture of what lies beyond the Milky Way.

The Phenomenon of Secondary Association.

By Dr. R. H. Richharia.
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THE discontinuity of chromosome associations observed at diakinesis and I metaphase in Prunus by Darlington (1928) led to the discovery of the phenomenon of secondary associations or secondary pairing. He suggested that the chromosomes showing this kind of affinity are related. This theory of secondary associations was further developed by Lawrence (1931 *c*) who adduced cytological and genetical evidence in favour of this theory and cited evidence of its occurrence from literature. Polyploidy occurs very frequently in the plant kingdom (at least fifty per cent. and probably more of the Angiosperm species, *cf.* Müntzing, 1936), hence this phenomenon is to be expected in all such forms. This has been now studied and described in detail by several workers in different materials: Lawrence (1929–31 *a* and *b*); Darlington and Moffett (1930); Moffett (1931); Meurman (1933); Wanscher (1934); Gustafsson (1935 *a*); Matsuura (1935); Heilborn (1935–36); Catcheside (1934); Gates (1935); Sakai (1935); Alam (1936). Recently Heilborn (1936) points out that he had already observed such associations in his studies on Carex (Heilborn, 1924) where he had also suggested that "this should probably be regarded as an expression of affinity between homologous gemini which arrange themselves in short rows of generally 3–5." He now thinks that "secondary association of chromosomes results from the action of the forces of nuclear division upon chromosomes of different size and mass," and he thus generalises, on insufficient grounds, that the chromosomes of equal size are associated irrespective of homology. Moreover, the presence of secondary pairing among chromosomes of unequal size observed (Richharia, 1936 *a* and *b*) is probably in direct contradiction to Heilborn's hypothesis, while the theory of secondary pairing allows such associations.

So far this phenomenon has been used only to determine the primary basic chromosome number, and has been shown to occur among bivalents which are morphologically the same. In our investigation (Richharia, 1936 *a* and *b*) on four Brassica species, *viz.*, *B. oleracea* ($n = 9$), *B. chinensis* ($n = 10$), *B. pekinensis* ($n = 10$), *B. Rapa* ($n = 10$) and *Raphanus sativus* ($n = 9$) associations among morphologically dissimilar types are observed. It has been suggested that such a condition may be due to certain structural rearrangements of chromosome parts, such as segmental interchange, fragmentation, translocation, etc., besides reduplication. Under these circumstances it will not be possible to disclose correctly the primary basic number in such forms. If such a hypothesis of "structural rearrangements" in explaining the secondary associations in these forms is correct it should be possible to detect such phenomena genetically. For example, Muller (1930) has shown in Drosophila that the translocations do to some extent influence the segregation of chromosomes, etc. It is quite probable that as a result of some sort of genetic balance or mutation primary pairing forming ring or chain does not occur in these forms and this relationship is shown only in the form of secondary associations. It is interesting to point out that Afify (1933) observed secondary pairing in *Lycopersicum esculentum* × *L. racemigerum* but not in the parents. He gives the following explanation for such a behaviour (p. 236). "It may be suggested that this secondary association in the hybrid is the result of the lack of sufficient homology between the chromosomes of the two parents. In other words, the homology between the corresponding 12 chromosomes contributed from each parent is not as strong as in the pure species. Consequently there is not a satisfactory primary association at the prophase of meiosis, and to fulfil their capacity for further pairing, they pair at metaphase through secondary association." He also points out some objections to the soundness of this explanation. The same behaviour may be explained on the following assumption: "Let us represent two chromosomes from each gametic set by **AaB**, **CcD** and **AaD**, **CcB** respectively. It is evident that under these circumstances no secondary association will occur in the parents but in the hybrid the two bivalents with the constitution $\frac{\mathbf{AaB}}{\mathbf{AaD}}$ and $\frac{\mathbf{CcD}}{\mathbf{CcB}}$ would form secondary pairing because of the presence of common B D." Heilborn (1936), however, suspects that the secondary association observed in this case may be due to bad fixation, which is hardly true.

This phenomenon is not confined to bivalents only. Whenever univalents fail to pair at prophase, possibly due to weak homology, they form secondary associations at I metaphase. This has been observed in swede × turnip cross by Catcheside (1934), Triploid *Pyrus minima* ($2n = 51$) by Moffett (1931), Taraxacum by Gustafssan (1934 *a* and *b*) and in Raphanus × Brassica hybrids by Richharia (1936 *a*).

It is held that secondary associations possibly do not affect segregation. But it is worth noting what happens in male Drosophila where crossing-over does not occur (especially see Darlington, 1934). Here chiasmata are not formed and the chromosomes are seen secondarily associated followed by regular segregation. It may thus be suggested that it is quite possible to expect similar behaviour with some secondarily associated univalent pairs as well.

REFERENCES.

Afify, A., "The cytology of the hybrid between *Lycopersicum esculentum* and *L. racemigerum* in relation to its parents," *Genetica*, 1933, **15**.

Alam, Z., "Cytological studies of some Indian Oleiferous Cruciferæ, III," *Ann. Bot.*, 1936, **50**.

Catcheside, D. G., "The chromosomal relationships in the swede and turnip groups of Brassica," *Ann. Bot.*, 1934, **48**.

Darlington, C. D., "Studies in Prunus, I and II," *J. Genet.*, 1928, **19**.

Darlington, C D., and Moffett, A. A., "Primary and secondary chromosome balance in Pyrus," *J. Genet.*, 1930, **22**.

Darlington, C. D., "Anomalous chromosome pairing in the Drosophila *Pseudo obscurar*," *Genetics*, 1934, **19**.

Gates, R. R., "Nuclear structure and chromosomes," *Nature, Roy. Jub.*, 1935, No. 135.

Gustafsson, A., " Primary and secondary association in Taraxacum," *Hereditas*, 1935 *a*, **20**.

Gustafsson, A., "Secondary association between homologous univalents," *Swensk Bot. Tidskr*, 1935 *b*, Bd. **28**.

Heilborn, O., "Chromosome numbers and dimensions, species formation and phylogeny in the genus carex," *Hereditas*, 1924, **5**.

Heilborn, O., "Reduction division, pollen lethality and polyploidy in apples," *Acta Horti Bergiani*, 1935, Bd. **11**, No. 7.

Heilborn, O., "The mechanics of so-called secondary association between chromosomes," *Hereditas*, 1936, **22**.

Lawrence, W. J. C., "The genetics and cytology of Dahlia species," *J. Genet.*, 1929, **21**.

Lawrence, W. J. C., "The genetics and cytology of *Dahlia variabilis*," *J. Genet.*, 1931 *a*, **24**.

Lawrence, W. J. C., "The chromosome constitution of *Cardamine pratensis* and *Verbascum phœniceum*," *Genetica*, 1931 *b*, **13**.

Lawrence, W. J. C., "The secondary association of chromosomes," *Cytologia*, 1931 *c*, **2**.

Matsuura, H., "On the secondary association of meiotic chromosomes in *Tricyrtis latifolia* Max. and *Dicentra spectabilis* Mig., *J. Fac. Sci. Hokkaido Imp. Univ. Ser.*, 1935, **3**, No. 5.

Meurman, O., "Chromosome morphology, somatic doubling and secondary association in *Acer platanoides* L.," *Hereditas*, 1933, **18**.

Moffett, A. A., "The chromosome constitution of the Pomoideæ," *Proc. Roy. Soc.*, B., 1931, **108**.

Muller, H. J., (1930), "Oenothera-like linkage of chromosomes in Drosophila," *J. Genet.*, 1930, **22**.

Müntzing, A., "Studies on meiosis in diploid and triploid *Solanum tuberosum* L.," *Hereditas*, 1933, **17**.

Müntzing, A., "The evolutionary significance of autopolyploidy," *Hereditas*, 1936, **21**.

Richharia, R. H., "Cytological investigation of *Raphanus sativus*, *Brassica oleracea* and their F_1 and F_2 hybrids," 1936 *a* (in press).

Richharia, R. H., "Cytological investigation of three 10-chromosome species of Brassica and their F_1 hybrids," 1936 (in press).

Sakai, K., "Chromosome studies in *Oryza sativa* L.—I. The secondary association of the meiotic chromosomes," *Jap. J. Genet.*, 1935, **11**, 145-56.

Wanscher, J. H., "Secondary (chromosome) associations in Umbeliferæ and Bicornes," *New Phytol*, 1934, **33**.

A Forgotten Authority on Lac Cultivation.

By S. Mahdihassan.

THE late Prof. Lefroy[1] once observed that the Indian lac experts do not seem to know anything of what is being done outside India. Unfortunately, it can as well be said that they do not even know all that has been published in India. An interesting publication on lac cultivation has not been referred to in the subsequent works on the subject, including the most recent book by Glover[2] and the Bibliography on Lac, published by the Lac Research Institute, Ranchi.[3] The forgotten Report is entitled, "A note on the cultivation of lac in Jangipur Subdivision of Murshidabad," by Romesh Chander Sirkar, dated 10th April 1904. It may be pleaded that the above publication contains nothing of importance; and, if so, it only reveals lack of appreciation of an important phenomenon to which I have devoted more than one publication.[4]

The variations among lac crops have been attributed to the mysterious effect of the weather. On the contrary I have explained how the yield regularly differs from locality to locality and from season to season, when we consider the following chain of factors: Excessive soil moisture, dilution of plant sap, increase in water content of eggs before fertilisation, preponderence of males in the next generation, the ultimate poor yield of the lac crop. At Ranchi they tried to verify such observations, without, however, mentioning any of my publications, and commented as follows: "*An* experiment was carried out to discover whether moisture was a factor governing male to female ratio.....*Experiments* so far have not shown moisture to be this factor."[5] (Italics are mine.)

Ranchi is apparently not so forward as to form an exception to Holdaway's[6] remark, "Little attention has been given......to the effect of humidity on insect populations." From his own experience he has been able to state, "Sex ratios of adults derived from parents or from eggs which had been maintained at respectively different moisture conditions were different......In this connection it is of interest to recall Mahdihassan's results, published in 1924 and 1926, on the change in sex ratios of lac insects to moisture condition associated with the season."

Granting that soil moisture does ultimately produce a progeny rich in males, a dry locality would produce good quality brood lac. Likewise in a large geographical area with elevated lands or hills with a well-drained subsoil would produce good brood lac, while the plains, rich in subsoil moisture, would be producers of inferior quality.

Sirkar considers, "the local insects (from the plains of Murshidabad) of a rather delicate nature," for they apparently die in numbers and thus the surviving members can only produce little lac. What he actually observed was a small survival ratio in the colonies of local origin, with a great deal of space separating isolated females and this space was imagined to be due to the high death rate among the female larvæ. On the other hand what he considers as the hardier insect, he "procured from Salgara-Pahar and Dumka-Pahar, *i.e.*, from the hilly tracts in the Sonthal Parganas, and introduced" them on his experimental trees. He adds, "Both the Pahari insects, *i.e.*, insects produced from the hill tracts and the local insects, were inoculated on the branches of the same trees." His experiments showed, "the Pahari insects were hardier (with a smaller death rate) and a little later in maturing than the local one." He finally writes, "I thought it better to inoculate both the varieties on the branches of the same trees and watch the result.... The Pahari lac incrustations were found to grow thicker than the local ones (from the plains). The Pahari insects deposited a layer, about one-fourth inch thick, of incrustation all round the upper three-fourth part of each branch, and thereby yielded a greater quantity of lac; while the local insects produced thinner deposits at intervals all along the branches."

A few comments are necessary to explain the importance of Sirkar's observations somewhat naively expressed.

1. He established a difference of quality in broodlac derived from an elevated locality and from the plains. This is a fact.

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1 *Pidance's Report on Lac-refining*, Hyderabad-Deccan, 1930.

2 *A Practical Manual of Lac Cultivation*, Ranchi, 1931.

3 *Bibliography of Lac*, 1933.

4 *Proc. Roy. Acad. Sc.*, Amsterdam, 1933, **36**, No. 3.

5 *Ann. Rep. Lac Res. Inst.*, Ranchi, 1930, 30.

6 *Ecological Monographs*, July 1932, **2**, No 3, p 268.

2. The broodlac from the hills gave rise to a generation which matured later. This can be explained as due to a greater ratio of females and the consequent competition for food, hence the slower rate of maturity; this difference, as Sirkar himself remarks, was not great.

3. Insects from the plains produced deposits thinner and at intervals. When a young colony with a preponderence of males is observed in the first larval stage, the colony appears densely populated. Two months later the males have emerged and the relatively few females appear scattered or isolated. The impression, and only an impression, is left that many female larvæ have died meanwhile, accounting for the empty gaps. By the time such a generation is fully developed the encrustation is thin and at intervals, as observed by Sirkar.

4. Brood lac from the hills gives an encrustation which envelopes three-fourths around a twig. When a twig is growing horizontally and it is most intensely populated by a lac colony it is never all around the twig; only the undersurface and the sides are covered, or if a cross-section is taken the *lower* three-fourths of the circumference would show larval settlement. When such a colony has lived long enough to complete its life cycle, the piece of sticklac, held in hand and examined for the encrustation, would show the *upper* three-fourths of the twig, in section, covered with lac, as Sirkar remarks. The important point to observe is that the colonisation was as intense as it could possibly be, which means, the generation derived from broodlac sent from the hills had a high ratio of females.

It would be seen that all remarks and observations made by Sirkar are accurate in themselves and become perfectly intelligible only when we consider them as extended effects of a preponderence of females in the progeny derived from broodlac of a hilly locality, and there appears no reason to assume that the insect there was in any way hardier or different in variety.

Hautefeuille,[7] unbiassed by any preconceived ideas, acutely observes, "In Upper Tonkin, *Cajanus* (plants) intended for the production of sticklac and especially for insect reproduction or for broodlac is found in very suitable localities, somewhat elevated." The suitable locality is the elevated locality, naturally with a soil having excellent drainage. He likewise says the reverse condition is not good for lac propagation: "*Cajanus* plantations which receive colonies of insects......need good alluvial soil which is not too moist." The moist unfavourable locality would correspond in Sirkar's experiments with the "plains". Sirkar also observed trees were growing "along the banks of rivers" and elsewhere liable to "occasional inundation"; apparently he never dreamt of utilising these trees for lac propagation for he never mentions them in connection with his observations on lac cultivation.

In order to extend lac cultivation in Indo-China[7] experiments were undertaken with broodlac procured through "coolies living in the mountainous regions." These "mountaineers came at much expense..... with brood-sticks and had been travelling for six days." It is apparent the broodlac from the hills must have an established local reputation, for otherwise it is difficult to imagine why it was not procured from a locality in the plains, which might also have been nearer.

In this connection I may add that Nicholson[8] reviewing different opinions with regard to elevation affecting lac cultivation, writes, "all the evidence in my opinion goes to show that elevation *per se* is a physico-geographical factor of no importance." By elevation which effects lac cultivation is to be understood that which is expressed in the contour of a land and in the movement of subsoil water; that which is measured in height above sea-level has naturally no bearing on it. Sirkar was thus the first to show experimentally that broodlac from a drier elevated locality is better than that obtained from the plains with a greater subsoil moisture.

[7] *Report on Lac and Its Industrial Treatment*, Hyderabad, Deccan, 1924.

[8] *Indian Forester*, 1925, **51**.

LETTERS TO THE EDITOR.

CONTENTS.

Density of Calcium and Hydrogen at Different Levels in the Sun.

A PHOTOMETRIC study of some of the prominent lines in the sun's spectrum at different points of the sun's disc has been carried out at the Kodaikanal Observatory.

As the sun's limb is approached the path of light through the reversing layer becomes more and more inclined to the vertical in the sun, but we find that the change in the contours of solar lines is quite different from that of terrestrial lines, such as the B band, as the path through the earth's atmosphere becomes more and more inclined to the vertical. In the latter case, the residual intensity at every point of the contour decreases with increased inclination of the path to the vertical, and the equivalent width correspondingly increases; whereas in the case of the solar atmosphere the residual intensity increases as the limb is approached, and the equivalent width correspondingly decreases.

This characteristic difference in the behaviour of solar and terrestrial lines in relation to the inclination to the vertical of the path through the atmosphere is due to the fact that in the case of the sun's reversing layer the photospheric background of continuous spectrum comes from a higher level as the limb is approached. The change in the contour of solar lines is a combination of two opposite effects:—(1) an increase in the number of absorbing atoms due to the increased length of path through the atmosphere as the inclination to the vertical increases, and (2) a decrease in the number of absorbing atoms as the effective level of the photosphere becomes higher. The first effect can be allowed for by geometric considerations, so that the change in the contours of solar lines can be used to measure the second effect. Hence we can measure the number of atoms lying above different levels in the sun, and consequently also the number of atoms between these levels. We have deduced in this way, the following values for the number of atoms per cm.^{3} at different levels in the sun:—

Height above photosphere	Number of atoms per cm.^{3}		
	Ca	Ca^+	H (2 quantum)
0 to 136 km.	$11 \cdot 3 \times 10^8$	$3 \cdot 68 \times 10^{11}$	$6 \cdot 13 \times 10^8$
0 to 287 km.	$9 \cdot 05 \times 10^8$	$3 \cdot 40 \times 10^{11}$	$3 \cdot 61 \times 10^8$
136 to 287 km.	$6 \cdot 95 \times 10^8$	$2 \cdot 55 \times 10^{11}$	$2 \cdot 01 \times 10^8$
0 to 600 km.	$5 \cdot 2 \times 10^8$	$1 \cdot 7 \times 10^{11}$	$2 \cdot 0 \times 10^8$
287 to 600 km.	$1 \cdot 6 \times 10^8$	$0 \cdot 4 \times 10^{11}$	$0 \cdot 2 \times 10^8$

The electron pressure is about 2×10^{-5} atmospheres at all these levels.

Although the number of H atoms in the 2 quantum state has been determined with reasonable exactness, it is well known that

the number of H atoms in the 1 quantum state in the sun is a matter of great uncertainty. Consequently the proportion of the metallic constituents of the sun is also very uncertain. Our results show that the proportion of calcium atoms is of the order of 0·6 per cent. of the total number of atoms present, a value about 10 times greater than Russell's estimate.

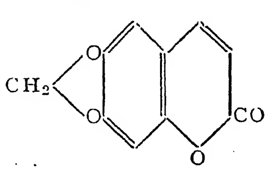
Further details of this work are being published in *Kodaikanal Observatory Bulletin No.* 109.

T. ROYDS.
A. L. NARAYAN.

Kodaikanal Observatory,
November 18, 1936.

On the Constitution of Ayapin.

THE isolation of pure ayapin from the leaves of *Eupatorium ayapana*, Vent. and its identity with 7-methoxycoumarin have already been reported by Bose and Roy.[1] The second crystalline constituent, obtained from the same source and named ayapin, melts at 219–20°. It imparts to concentrated sulphuric acid a sky-blue fluorescence. Ayapin was found to be free from methoxy groups but the presence of methylenedioxy group was indicated. Its analyses agreed with the formula $C_{10}H_6O_4$. Reduction with sodium amalgam in faintly acid medium gave a dihydro-compound, m.p. 175-177° which did not any longer show fluoresence in concentrated sulphuric acid. Treatment of ayapin with bromine followed by alcoholic alkali gave an acid, m.p. 269–71° (with evolution of gas) which is evidently formed as a result of coumarin-coumarilic acid rearrangement. We suspected ayapin to be a methylenedioxycoumarin, and this supposition has been confirmed by a synthesis of ayapin from 6 : 7-dihydroxycoumarin by methylenation. The identity of the synthetic 6 : 7-methylenedioxycoumarin (I) with ayapin has been



(I)

established in the usual manner.
the authors are aware, ayapin i
instance of a methylenedioxycouma
in nature.

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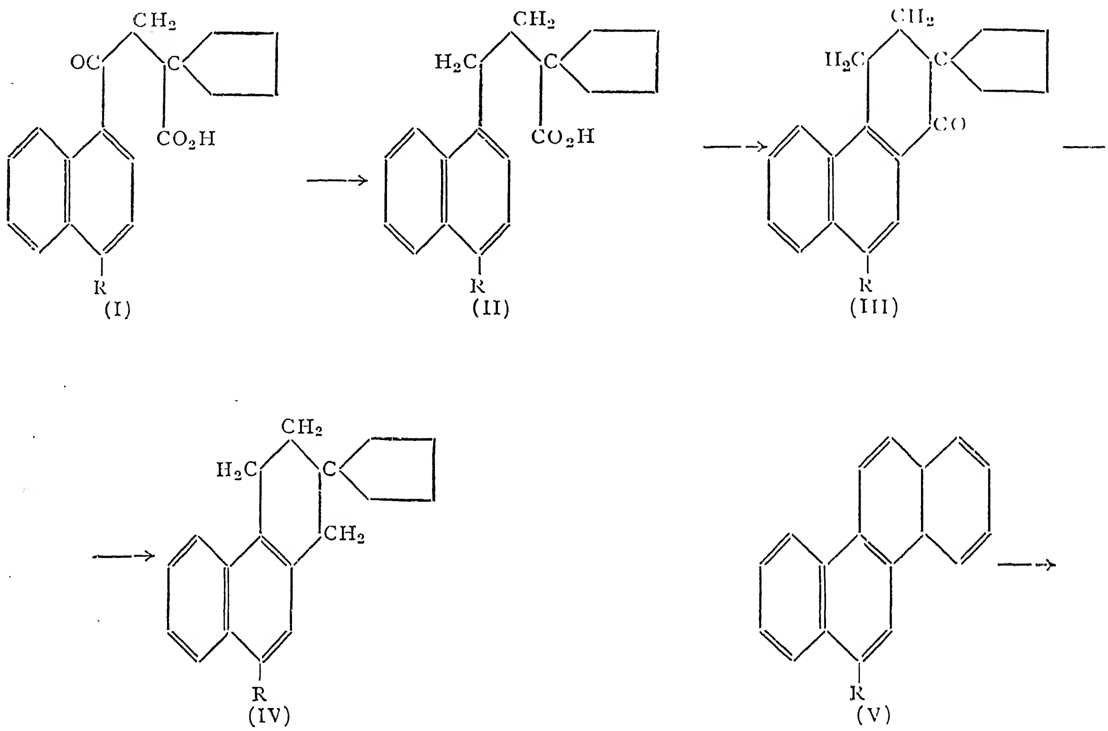
November 20, 1936.

[1] *J. Indian Chem. Soc.*, 1936, **13**, 586.

Dehydrogenation and Ring-Transformation of Spiro-Hydrocarbons.

BY an extension of the method developed by the author for the synthesis of spiro-hydrocarbons[1], 1, 2, 3, 4-tetrahydrophenanthrene-2, 2-spiro-cyclopentane (IV ; R = H) and its 9-methyl derivative (IV ; R = Me) have been synthesised. And similar to the observations made in that paper, these spiro-hydrocarbons were found on selenium dehydrogenation to be converted by ring-transformation into chrysene and 6-methyl chrysene respectively.

The steps that led to the syntheses of these two spiro-hydrocarbons were as follows: The anhydride of cyclopentane-1-carboxy-1-acetic acid reacted with naphthalene in presence of anhydrous aluminium chloride with the formation of $\alpha\alpha$-cyclopentane-β-1-naphthoyl-propionic acid (I ; R = H) (m.p. 40–141°) and $\alpha\alpha$-cyclopentane-β-2-naphthoyl propionic acid (m.p. 191°). The former on reduction by the Clemmensen method gave $\alpha\alpha$-cyclopentane-γ-1-naphthyl butyric acid (II ; R = H) (m.p. 108–109°) which was cyclicised with 85% sulphuric acid to 1-keto-1, 2, 3, 4-tetra-hydro phenanthrene-2, 2-spiro-cyclopentane (III ; R = H) (b.p. 215°/6 mm.). This spiro-ketone was reduced by the Clemmensen method to the spiro-hydrocarbon 1, 2, 3, 4-tetrahydrophenanthrene-2, 2-spiro-cyclopentane (IV ; R = H), and the latter on selenium dehydrogenation at 300–350° gave only chrysene and no trace of benzanthracene could be detected. It may be noted here that both phenanthrene and anthracene were obtained by the selenium dehydrogenation of 1, 2, 3, 4-tetrahydronaphthalene-3, 3-spirocyclopentane.[1]



(I) (II) (III) (IV) (V)

In a similar manner $\alpha\alpha$-cyclopentane-β-(4-methyl)-1-naphthoyl-propionic acid (I; R = Me)(m.p. 176–177°) was obtained from α-methyl napthalene and the anhydride of cyclopentane-1-corboxy-1-acetic acid. The methyl ester of this keto acid was reduced by the Clemmensen method to $\alpha\alpha$-cyclopentane-γ-(4-methyl)-1-naphthyl butyric acid (II; R = Me) (m.p. 112°), which on cyclisation with 85% sulphuric acid gave 9-methyl-1-keto-1, 2, 3, 4-tetrahydrophenanthrene-2, 2-spiro-cyclopentane (III; R = Me) (m.p. 97°). This spiro-keto compound on Clemmensen reduction yielded the spiro-hydrocarbon 9-methyl-1, 2, 3, 4-tetrahydrophenanthrene-2, 2-spiro-cyclopentane (IV; R = Me) (m.p. 69–70°). On dehydrogenation with selenium at 300–350° it gave 6-methyl chrysene (m.p. 152–53°) (V; R = Me).

The experimental details will shortly be published elsewhere.

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December 7, 1936.

[1] *J. Ind. Chem. Soc.*, 1934, 389.

Individuality of Ascorbic Acid Oxidase.

BESIDES the oxidation of ascorbic acid b peroxidase systems,[1,2] the presence in plan extracts of a specific enzyme capable of ox dising ascorbic acid has been assumed b different workers.[3,4,5,6] As such plant e: tracts are not free from peroxidase,—thoug Tauber *et al.*,[5] do not refer to this point- circumstantial evidence was obtained pr viously by the author[6] to show that tl peroxidase accompanying ascorbic acid ox dase in drumstick, *Moringa pterygosperm* had no rôle in the oxidation of ascorbic aci As a peroxidase-free ascorbic acid oxida alone could speak for its individuality, preparation of such an enzyme has now be obtained, after careful search among differe plant materials, in the *press* juice of the inn pulp of cucumber, *Cucumis sativus*. This jui was found to oxidise ascorbic acid rapidl (Table I) under optimum conditions[6] a was free from peroxidase systems as teste with the usual substrates and H_2O_2 and wi starch-iodide (Table II).

TABLE I.

Ascorbic Acid Oxidase Activity of the Press Juices of the Rind and Inner Pulp of Cucumber.

Reaction mixture: 0·5 mg. ascorbic acid in a total volume of 5 ml. at pH 5·3 and room temperature (25° C.).

mg. ascorbic acid oxidised in 5 minutes by		
No enzyme (control)	0·5 ml. rind juice	0·5 ml. pulp juice
0·0	0·56	0·57

TABLE II.

Peroxidase Activity (Bach and Chodat[7]) of the Press Juices of the Rind and Inner Pulp of Cucumber.

Recation mixture	Ml. iodine (= N/200 $Na_2S_2O_3$) liberated in 3 mins.
5 ml. starch—iodide[7]+0·5 ml. H_2O_2 (0·3%)[7] +0·5 ml. H_2O	0·41
5 ml. starch—iodide+0·5 ml. H_2O_2 (0·3%) +0·5 ml. pulp juice	0·39
5 ml. strarch—iodide+0·5 ml. H_2O_2 (0·3%) +0·5 ml. rind juice	1·59
5 ml. starch—iodide+0·5 ml. H_2O+0·5 ml. rind juice	0·00

The peroxidase which cucumber is known to contain was located in its rind, the *press* juice of which was also as active as that of the inner pulp in oxidising ascorbic acid (Table I), suggesting an even distribution of ascorbic acid oxidase in the pulp and the rind of cucumber. As the correctness of this suggestion rested on the inability of peroxidase of the rind to oxidise ascorbic acid, it was shown that the rind juice did not contain a peroxide (Table II, which, besides, gives peroxidase activity), a complement necessary for the oxidising action of peroxidase. Hence the capacity of even the rind juice to oxidise ascorbic acid is due to the specific oxidase and not due to the co-existing, but incomplete peroxidase.

Thus, ascorbic acid oxidase is individualistic and can occur either alone, or mixed with peroxidase (or other oxidases). So, wherever a peroxide-free enzyme system, capable of oxidising ascorbic acid is encountered, it appears safe to assume, in general, the presence of a specific and individual ascorbic acid oxidase.

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December 4, 1936.

1 Szent-Györgyi, *Biochem. J.*, 1928, **22**, 1387.
2 Szent-Györgyi and Vietorisz, *Biochem. Z.*, 1931, **233**, 236.
3 Szent-Györgyi, *J. Biol. Chem.*, 1931, **90**, 385.
4 Zilva, *Biochem. J.*, 1934, **28**, 663.
5 Tauber, Kleiner and Mishkind, *J. Biol. Chem.*, 1935, **110**, 211.
6 Srinivasan, *Curr. Sci.*, 1935, **4**, 407.
7 Bach and Chodat, *Berichte*, 1904, **37**, 1342.

The Non-Protein-Nitrogen of Milks.

MILKS from different species of animals are known to contain an appreciable amount of the Non-Protein-Nitrogen (N.P.N.) fraction probably influencing their nutritive value in three ways: (1) affecting the peptisability of the proteins, (2) influencing their digestibility and (3) supplementing any deficiencies of the associated proteins. A study of this fraction is therefore of considerable interest.

The results presented in this communication relate to the partitioning of the N.P.N. fractions of the cow and ass milks by the Van Slyke's method and to the estimation of the urea and arginine contents by the application of enzyme methods.

TABLE I.

Percentages of Total Nitrogen.

	Ass Milk	Cow Milk
Melanin	7·02	6·03
Amide N	15·5	12·56
Non-basic N:		
Amino N	50·14	52·00
Non-amino N ..	2·76	1·65
Basic N	25·84	29·15
Total ..	101·26	101·49
Arginine (Van Slyke) ..	17·59	11·53
,, (Enzyme) ..	7·15	7·33
Urea (Total) ..	21·21	20·29

The results presented in Table I do not reveal any significant differences between the composition of the N.P.N. of cow and ass

milks. The higher values for amide are due to the partial decomposition of urea under the conditions of acid hydrolysis of the N.P.N. The actual values for amide, after correcting for the presence of the urea are respectively 2.0, 1.06 for cow and ass milks. The discrepancy between the values for arginine by enzyme and alkali methods can also be attributed to the residual urea present in the hydrolysate. It will be seen that as in the case of N.P.N. of pulses,[1] the arginine values obtained by the alkali method are distinctly higher and in the case of milk N.P.N. the higher values are due to partial hydrolysis of urea by alkali.

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November 6, 1936.

[1] *Curr. Sci.*, 1936, **4**, 651; *Biochem. J.*, 1936, **30**, 1416.

A Note on the Mydriatic Effect of Cocaine in Cat's Eye and Its Differentiation from the Atropine Group of Alkaloids.

COCAINE, like the atropine group of alkolids, produces mydriasis in cat's eyes, but it was found that a watery solution of cocaine hydrochloride of a strength less than what is represented by 0.025 per cent. solution of cocaine base had no effect in the cat's eye even on repeated applications, whereas a solution equivalent to 0.025 per cent. of cocaine base reacted in the eyes of some cats, but produced no effect in those of others. The dilatation was noticeable in shade, but not in the sun or strong light. 0.05 ml. of 1 per cent. coc ine solution caused moderate dilatation in an hour as seen in the shade. In the presence of strong light the pupil contracted to a certain extent, but slight dilatation was still perceptible. In this respect cocaine differs from atropine, which reacts in the cat's eye more definitely in strong light.

0.025 per cent. (1 : 4000) of cocaine solution may be considered as the lowest which is capable of producing a mydriatic effect in cat's eyes, whereas a considerably weaker solution (1 : 130,000 according to Donders: Otto "Ausmittelung d. Gifte," 6te Aufl., 73) of atropine gives positive mydriatic reaction in the cat's eye.

Another point of difference is that a weak solution of cocaine (less than 0.025 per cent.) does not, unlike weak atropine solutio cause a cumulative effect in the eyes of cat on repeated applications.

It has been found that a drop of 0.0 per cent. cocaine solution gives a positi permanganate reaction on a slide (*cf.* Hanki *Analyst*, 1911, 2) if applied in the presen of a drop or two of N/25 HCl, special when the liquid dries up.

This investigation was carried out und the facilities kindly afforded to me Mr. D. N. Chatterji, B.A., B.Sc., F.I.C., th Chemical Examiner to Governments of th United Provinces and C. P., in his laborator

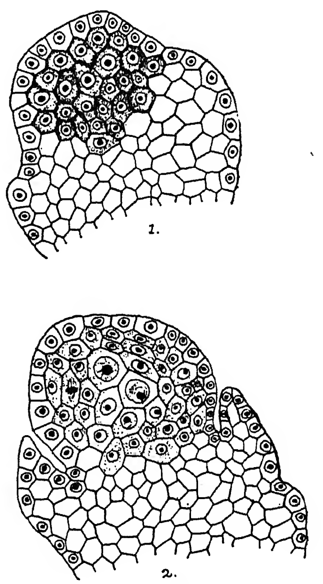
I am greatly indebted to him for his kin permission to send this paper for publicatio

K. R. GANGULY.
Government Laboratory,
Agra,
October 12, 1936.

Megasporogenesis and Embryo-sac Formation in Two Species of Meliaceæ.

No previous work has been done on th morphology of Meliaceæ. For the first tim two species of the Meliaceæ—*Cipadess fruiticosa*, Bl., and *Melia azaderach* Linn have been worked.

The archesporium consists of a group cells, hypodermal in origin and easily recog nised before the integuments are differen tiated (*Melia*, Fig. 1; *Cipadessa*, Fig. 1).



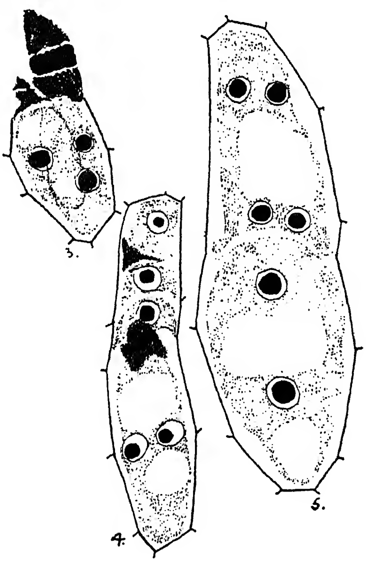
Figs. 1 & 2.

The archesporial cells cut off parietal cells and later are found deeply situated in the nucellus. Most of them degenerate, and the functional megaspore mother cells are easily recognizable by their large size and big nuclei (*Melia*, Fig. 2).

After the meiotic divisions, a linear tetrad of cells is formed in *Melia* while *Cipadessa* shows a T-shaped Tetrad of which the chalazal megaspore develops into the embryo-sac (Fig. 2). It is interesting to find in *Melia* any member of the tetrad irrespective of its position becoming the functional megaspore.

Though only a single megaspore functions to give rise to the female gametophyte ultimately, cases have been seen where two of the megaspore mother cells develop simultaneously.

In *Melia*, Fig. 3 shows two megaspores, one developing into a two-nucleate embryo-sac and the other into a uni-nucleate one. Fig. 4 shows a linear tetrad and a binucleate embryo-sac each having developed by different megaspore mother cells. Fig. 5 shows one developing into a four-nucleate embryo-sac and the other into a binucleate one. Finally



Figs. 3, 4 & 5

only one embryo-sac is found in each ovule, the others degenerate gradually.

In *Cipadessa* two megaspore mother cells have been found to develop up to the first meiotic changes.

The mature embryo-sac is typically eight nucleate in both *Melia* and *Cipadessa*. In *Melia* the micropylar end is broad and the antipodal is narrow (Fig. 6). The synergids are equal to the egg in size which is situated

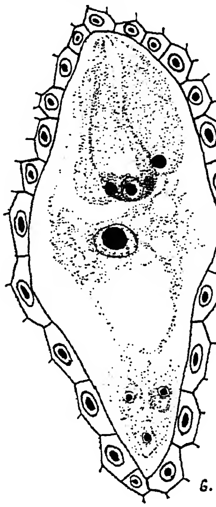


Fig. 6.

between them and take a dark stain. The polar nuclei have already fused producing a large fusion nucleus and antipodals show signs of degeneration.

The same holds good in the case of *Cipadessa* also except for the fact that the synergids are more massive and beaked. Unlike *Melia* the identity of the two polars are not still entirely lost in the fusion nucleus. The antipodals here also show signs of degeneration (Fig. 3).

Melia.		*Cipadessa.*	
Fig. 1.	× 450.	Fig. 1.	× 630.
Fig. 2.	× 450.	Fig. 2.	× 900.
Fig. 3.	× 900.	Fig. 3.	× 900.
Fig. 4.	× 900.		
Fig. 5.	× 900.		
Fig. 6.	× 900.		

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November 1936.

Deciduous Sessile Spikelets in Sorghum.

IN cereals persistent spikelets are a necessary economic equipment. An absence of deciduous spikelets characterises economic varieties; but the degree of persistence might vary. Deciduousness is a characteristic of the wild relations of cultivated cereals. This deciduousness may be of two kinds. In *Aegilops*, *Avena*, *Hordeum*, *Secale*, and

Triticum[1] spikelets shed owing to the fragileness of the rachis which snaps off and sheds down the spikelets with bits of rachis attached. In Rice[2] there occurs a shedding of the spikelets alone, consequent on the formation of callus at the place of articulation.

In sorghum with its usual single stalks and single heads, the problem of shedding is a serious handicap in economic varieties. Most cultivated sorghums are devoid of this defect so that persistent spikelets are the rule. The spikelets of sorghum are pedicelled or sessile. Pedicelled spikelets do not usually bear grains. In most cultivated varieties pedicelled spikelets are deciduous but in some they persist. This character has been used by Snowden[3] to differentiate varieties. Deciduous sessile spikelets are confined to wild sorghums (series *Spontanea*). In *Sorghum halepense* (Linn.) Pers., *S. arundinaceum* Stapf., and *S. virgatum* Stapf., the sessile spikelets drop off due to callus formation at the articulation between the pedicel and the base of the spikelet. In *S. sudanense* Stapf., the pedicels snap. This character of shedding through callus formation of the snapping of pedicels has been used by Coleman[4] to help farmers in Australia to separate *S. halepense* from *S. sudanense*. Snowden[3] records the fact that in Africa the wild races with shedding spikelets freely intercross with cultivated varieties. He refers to the practice prevalent among the farmers there, of vigilance in the eradication of such natural crosses. One of these wild African shedding types M. S. 1481 was received at Coimbatore through the courtesy of Kew. This type was like cultivated sorghum till heading and betrayed its wildness only at the milky stage when the sessile spikelets started shedding. At maturity all the pedicelled spikelets had shed and of the sessile spikelets all but a few had done so. The pedicels of the shed spikelets had a cup-like depression at their ends into which the base of the spikelets had fitted (*vide* illustration). An examination of five earheads showed that from 7 to 12 per cent. of the sessile spikelets remained attached to the earhead. The rest had shed. This habit of shedding persisted in the next and subsequent years. In the year 1934 natural crosses with neighbouring cultivated varieties were spotted among the wild population. These crosses had persistent spikelets. Three of these were sown and all of them segregated as follows:—

Selection No.	Spikelets Non-shedding	Spikelets Shedding
A. S. 3988	46	11
„ 3989	69	22
„ 3990	53	18
Total (observed) ..	168	51
Calculated 3 : 1 ..	166.5	55.5

$X^2 = \cdot 054$ $P > 0 \cdot 8$

It will be noted that the shedding character has proved a simple recessive to the non-shedding character. The gene responsible for shedding has been designated *sh*. *Sh* produces the normal non-shedding sessile spikelets. *Sh* is a simple dominant to *sh*.

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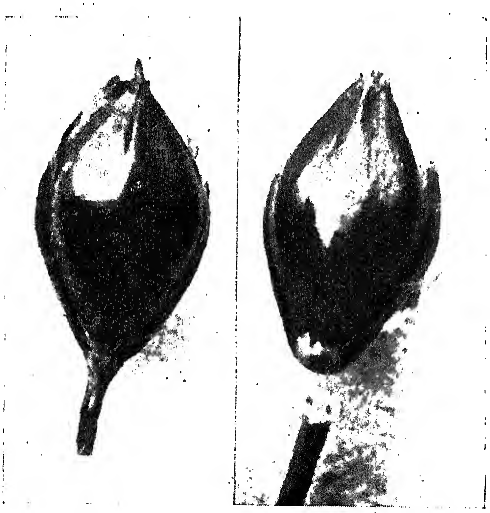
B. W. X. PONNAIYA.
Millets Breeding Station,
Coimbatore,
September 24, 1936.



Persistent Deciduous

Sorghum Spikelets

1 Matsuura, H., *A Bibliographical Monograph of Plant Genetics*, (1900-29), 1933.

2 Yoshito Yamasaki, *Jap. J. Bot.*, 1928, 4, Abs. 354.

3 Snowden, *The Cultivated Races of Sorghum*, 1936.

4 Coleman, *Queensland Agrl. Jour.*, 1936, 45, 602.

Albinism in *Eleusine indica* Gaertn.

THE occurrence and inheritance of albinism in ragi, *Eleusine coracana* Gaertn. have been reported.[1] Two factors C_1 and C_2 either alone or together are responsible for production of chlorophyll on the plant. A similar experience has been met with in *Eleusine indica* Gaertn. In some importations of ragi (called the African millet) from Africa, there were mixtures of *Eleusine indica* plants. A number of these plants were isolated and grown. Of these seven threw albinos. Counts taken showed that in every case there was an approximation to the 15 : 1 ratio of greens to alibnos. One of these families E. I. 1 gave 167 greens and 11 albinos. All the albinos naturally died after about the tenth day. Forty-eight selections were carried forward from among the greens. Of these twenty-two gave green seedlings only. Twelve families segregated and gave a 15 : 1 ratio of greens to albinos (actual 1230 : 83). Fourteen families segregated and gave a 3 : 1 ratio of greens to albinos (actual 1904 : 643). These figures prove the existence of two factors responsible either alone or together for the production of chlorophyll in *Eleusine indica* also.

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Millets Breeding Station,
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[1] *Indian Jour. Agr. Sci.*, 1931, I (V), 569–76.

A Note on the Pistillody in *Hibiscus syriacus*, Linn.

PISTILLODY of the floral parts like sepals, petals, stamens and even ovules is of general occurrence among the Angiosperms, and several instances of the kind have been on record.[1] Dr. Agharkar has reported a case of pistillody of the stamens in *Hibiscus esculentis* in 1925,[2] wherein he has stated that the pistils have open ovary with one or two ovules, a well developed style and stigma. Recently several flowers of *Hibiscus syriacus* have been observed to exhibit this phenomenon of pistillody (Fig. 2); but whether these are cases of pistillody of the stamens is difficult to state on account of the unusual position of the pistil on the column. *Hibiscus syriacus* has got a staminal tube in the flower, upon which stamens are found in whorls right up to the end. The staminal tube itself ends in five

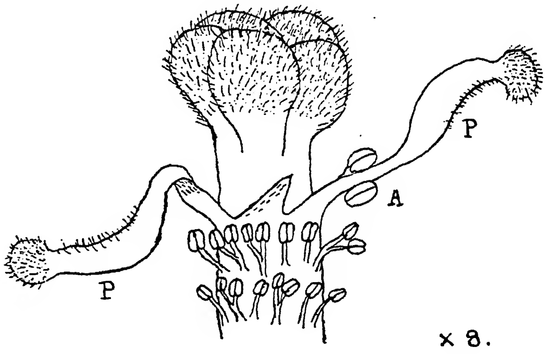

FIG 1.

Terminal portion of the column of *H. syriacus* showing clearly the lobes of the staminal tube and the point of origin of the pistils. × 8.

tooth-like lobes just below the stigmatic branches, sometimes even touching them. Some of these lobes ranging from one to three in some flowers were found to resemble pistils, not of the normal *Hibiscus* type but of the apocarpous type. The three regions of these pistils such as the ovary,

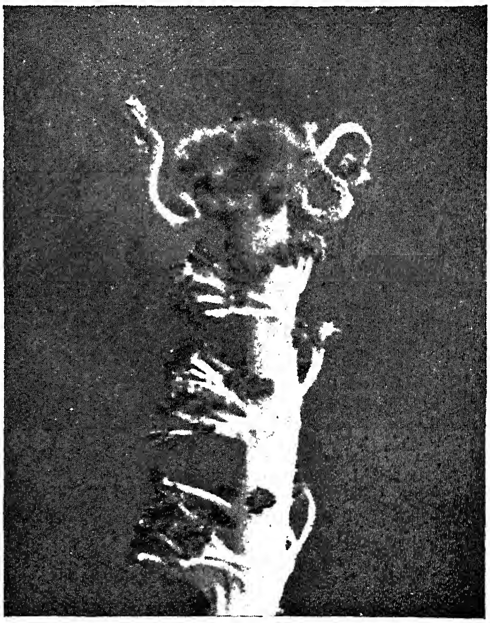

Fig. 2.

Photograph of the above showing three pistil and their position on the column. × 6.

style and stigma can be made out very distinctly. On account of their close proximity to the stigmatic lobes of the flower, they appear to arise from the base of the stigmatic lobes. In all the cases of pistillody

of the stamens that have been recorded so far, such pistils have replaced a functional stamen on the column. In the present case, the position of the pistil is different, and it does not replace a functional stamen. Further, in some cases, the pistil appears to be clearly a continuation of the connective of a stamen (Fig. 1). The pistil in these instances, possesses two functional anthers on two sides at its base. All the pistils observed so far, have ovaries of the closed type without ovules.

As suggested before, this peculiar case of pistillody cannot be considered as pistillody of the stamens for reasons stated above. There is, on the other hand, sufficient evidence to consider it as the lobes of the staminal tube modified unto pistils, with mono-carpellary unilocular ovary. In Fig. 1, two of the five lobes of the staminal tube are modified into pistils, the other three remaining quite normal and unmodified. Further, the lobes of the staminal tube can develop functional stamens on their surface, sometimes even though they are otherwise modified. The fact that in Malvaceæ, each stamen splits into halves each bearing a unilocular anther[3] eliminates the other possible explanation from consideration, *viz.*, the pistil to be taken as the modified connective of a stamen situated on one of the lobes of the stamenal tube.

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Department of Botany,
Mysore University,
Bangalore,
December 4, 1936.

1 Masters, M. T., *Pflanzen Teratologie*, 1886.
2 Agharkar, S. P., Abstracts of Papers, *Ind. Sci. Cong.*, 1925, p. 108.
3 Goebel, K., *Organography of Plants*, Eng. Ed., 1905, pt. 2, p. 536.

Notes on Floral Monstrosities in Maize (*Zea mays* L.).

MAIZE is a very plastic crop displaying a great variety of abnormalities already recorded by several workers.[1, 2, 3] Among the cultural lines, last year certain interesting cases have come to notice, two of which are of special interest, because as far as is known, they do not seem to have been described before. Therefore, a short illustrated note has been appended in each case.

SPECIMEN No. 1.

In one cultural line about 50 per cent. of the plants presented an unusual kind of abnormality. Such plants terminally bore tassels of a peculiar nature (Fig. 1) bent in a downwardly direction in the form of an S and were prominently marked by the absence of husks. The flowers in the spikelets of these tassels were all found to be hermaphroditic. The majority of them had fertile gynœcia but abortive stamens. Only towards the distal end (as indicated by an arrow in Fig. 1) of the tassel, the situation was just the reverse, *viz.*, the gynœcia were abortive and the stamens were fertile possessed of normal viable pollen grains. The number of stamens, whether fertile or abortive, was three in each flower. At a

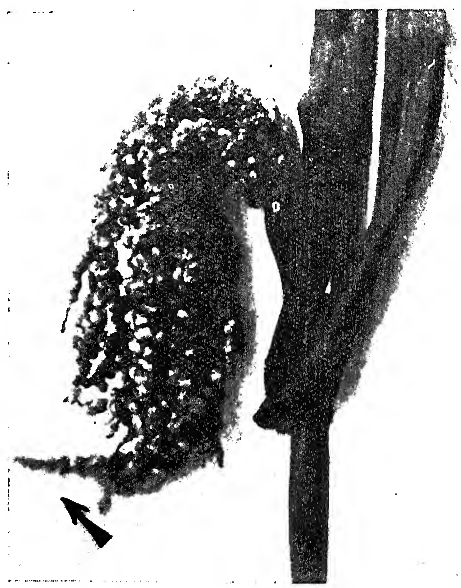

Fig. 1.

Zea mays L. A downwardly bent "Tassel" showing the well-developed grains. × 1/3.

later stage, however, normal well developed balloon-shaped grains were found to have been developed on the peculiar tassel described (Fig. 1). At the same time it is interesting to note that the cobs situated laterally on plants bearing such tassels externally looked quite normal but on removal of husks, they were found to be completely devoid of kernels or vegetative buds.

Seeds from such abnormal plants have, during the present season, given rise in most

cases to plants bearing abnormal tassels of exactly a similar nature as observed in the preceeding season. This shows that the phenomenon described is genetic and is heritable as a dominant character in a similar manner as known in certain maize with "*tassel-seed*."[4]

Since this was written my attention was drawn to the excellent work of Eyster, where he describes[5] a more or less similar type of abnormal tassel designated as "*tassel-seed*" which has been figured and described as bent in a downwardly direction (not like an S) alone with a complete absence of staminate flowers. Moreover, he does not at all describe the condition of the lateral cobs on the plans bearing the "*tassel-seed*".

Fig. 2.

Ibid. A head-like cob showing an aggregation of vegetative buds. The downwardly hanging leaves are the husks (H). × 1/2.

SPECIMEN NO. 2.

In another cultural line five plants were found to bear laterally headlike globular cobs (Fig. 2), possessed of 8–10 husks (Figs. 2–3 H), arranged in two gropus (of 4–5 each) on either side forming an imperfect covering. On closer examination after the removal of the husks, it was found that the axis of the cob was shortened (Fig. 3 A) bearing a number of vegetative buds (Fig. 3 B) in place of grains. There

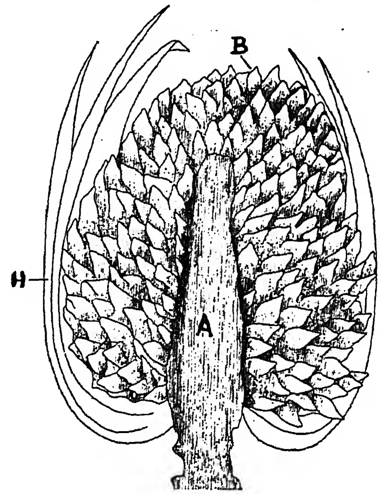

Fig. 3.

Ibid. The same head (as figured in Text-Fig. 2) in longitudinal section showing the shortened axis (A) together with numerous buds (B) and the husks (H). × 1.

was, however, no vestige of the essential organs left in them. The individual buds had a growing apex surrounded by small foliage leaves. The case appears to be an extreme one of a complete proliferation of reproductive spikelets into potential vegetative shoots.

Eyster has described an abnormal cob approaching the condition described presently But in his specimen there is a complete absence of husks, and the spikelets are usually completely sterile with greatly enlarged glumes.[6] Nowhere does he make a reference to the remarkable presence of vegetative buds as seen in my specimen.

I am very much indebted to Dr. T. C. N. Singh for useful suggestions and helpful criticisms and to Rao Bahadur G. N. Rangaswami Ayyangar, Millets Specialist, Coimbatore, for drawing my attention to Eyster's work.

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October 10, 1936.

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[1] Burtt-Davy, J., *Maize, Its History, Cultivation and Uses*, 1914, pp. 78–113.

[2] Schaffner, J. H., "Sex reversal and the experimental production of neutral tassels in *Zea mays*," *Bot. Gaz.*, 1930, **90**, 279–98.

[3] Eyster, W. H., "Genetics of *Zea mays*," *Bibliographica Genetica*, 1934, Deel **11**. (See bibliography on pp. 330–53).

[4] Types of maize having lateral and terminal inflorescences bearing exclusively pistillate flowers. (Emerson,

R. A., "Heritable characters of maize II–Pistillate flowered maize plants," *Jour. Heredity*—1920, **11**, 65–76; Phipps, I. F., "Heritable characters in maize XXXI—Tassel Seed$_4$," *Jour. Heredity*, 1928, **19**, 399–413.

[5] Eyster, W. H., *Ibid.*, 1934, 221-22, 57-258, figs. 17 and 60.

[6] Eyster, W. H., *Ibid.*, 1934, 264, Fig. 69.

The Antennæ of Aleurodidæ.

OBSERVATIONS on the adults of white flies have revealed a diversity of structure with regard to their antennæ, uncommon among other families of Rhynchota. The commonest form of the antenna is a filamentous structure consisting of seven more or less imbricate segments bearing fringed sensoria and spines. The general arrangement of these sensoria and spines is fairly uniform. Thus in most species there are two sensoria and a spine near the distal end of the third segment; a single sensorium at the distal extremity of the fifth segment; a spine about the middle of the sixth segment; and a sensorium with a spine on the distal half of the terminal segment (Fig. 1 *a*). Deshpande[1] has observed a more or less similar arrangement among the British species studied by him.

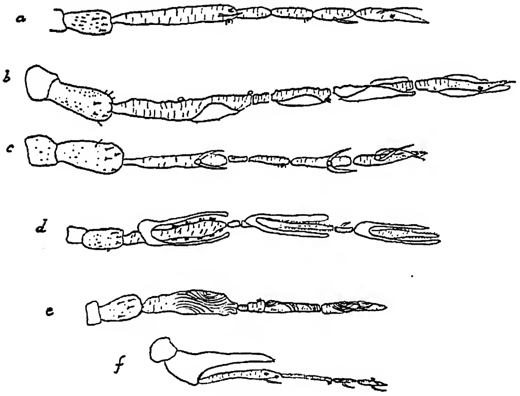

Fig. 1.

Some Indian species show a considerable deviation with regard to the form and arrangement of these sense organs on the antennal segments. To mention a few instances, in *Dialeurodes eugenii*, Maskell,[2] there are the usual sensoria, but the spines are completely absent, being replaced by conspicuous, transparent, tubular structures opening at both ends. The arrangement of these curious sense organs is shown in Fig. 1 *b*. In *Dialeurodes trilobitoids*, Q and B, the spines are paired and blade like, each pair arising from the same base; these being present on the third, sixth and seventh segments (Fig. 1 *c*). In the males of *Aleurotrachelus cœrulescens*, Singh, the sensoria cover the major portion of the third, fifth and the seventh segments, and the elongated spines appear to form a sort of protective covering for them (Fig. 1 *d*). Among the males of *Aleurocanthus longispinus*, Q and B, the corresponding segments are without spines, instead of being furnished with a complicated series of grooves and ridges, the arrangement of which is shown in Fig. 1 *e*. Lastly in *Aleuroclava complex*, Singh, the second segment of the antenna of the male is highly modified, the third segment arising near about its base (Fig. 1 *f*).

In certain cases these structures are far more developed in one sex than in the other; and in nature males have often been observed rubbing their antennæ against those of a female prior to copulation. In such cases there is the probability that they function to stimulate the other sex. A detailed investigation on these structures is being undertaken to see if it can throw some light on the causes of these prominent structural differences.

The classification of the group is so far principally based on the characters of the pupa cases, as the adults are known in comparatively very few cases. In the light of the above observations, it is obvious, that the classification of the family will need a drastic revision, when based on the morphological characters of the adult, including the structure of its antenna.

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October 6, 1936.

[1] *Trans. Roy. Ent. Soc.*, 1933, **81**, 118.

[2] *Mem. Dept. Agric.*, 1931, **12**, 25.

On Certain Abnormalities in the Sacrum of *Rana hexadactyla*.

THE iliosacral attachment in the Anura shows some variations, although in general the 9th vertebra acts as the sacral. According to Gadow,[1] *Pelobates* has two sacral vertebræ, the 10th and the 9th, a condition which is generally regarded as the most primitive amongst the Anura. In *Pipa* the sacrum is formed by the 9th and the 10th vertebræ, whose diapophyses have fused into

extra broad wing-like expansions. *Paleobatrachus* shows a slightly more advanced condition, the iliosacral attachment being formed not only by the 9th and the 8th but also to a certain extent by the 7th as well. The most advanced state is found in *Hymenochirus* in which the ilium has progressed so far that it has effected its attachment with the 6th vertebra. The Ranidæ are said to be a very stable group, the iliosacral attachment in these forms being at the 9th.

In the material under consideration, we notice that the iliosacral attachment has progressed forwards from the 9th vertebra, though the articulation is at the 9th. This

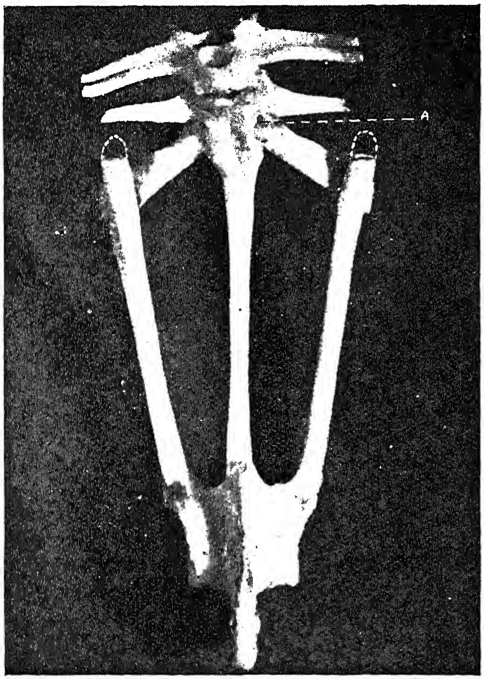

Fig. 1.

Ventral view, A = Exit for spinal nerve. Dotted line shows position of cartilage.

has been noticed in more than a dozen skeletons of *Rana hexadactyla* prepared for class use.

One of these, illustrated here, shows certain peculiarities, the urostyle near its anterior end having on its right side a small foramen, probably an exit for a nerve. Here evidently the 10th vertebra has not completely fused with the urostyle. The centrum of the 9th vertebra has completely fused with the urostyle behind, and with the centrum of the 8th vertebra in front. The exits for the spinal nerves between these vertebræ are quite clear and the diapophyses are wide apart. The anterior end of the centrum of the 8th vertebra does not show a clear articular surface—this as well as the posterior end of the 7th being very rough, showing thereby a tendency for fusion. The 6th and the 7th vertebræ have their centra well fused. Their diapophyses are situated very close together, thus reducing considerably the size of the foramina for the spinal nerves. The ilia project far in front of their articulation with the diapophyses of the 9th vertebra. We have noticed, that in the dried skeletons the cartilaginous ends of the ilia shrivel up, so that if we allow for the cartilaginous pieces in continuation of the anterior ends of the ilia, the iliosacral attachment will be seen to approach very close to the diapophyses of the 8th vertebra.

This forward movement of the iliosacral attachment has been observed by us, as already stated, in a large number of skeletons prepared in the laboratory. Further examination is being conducted to see if this is a tendency towards racial change.

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December 4, 1936.

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[1] H. Gadow, *Camb. Nat. Hist.*, 8 (Macmillan & Co.).

Annual Recurrence of Rusts in Eastern Russia.

By B. B. Mundkur.

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IN regions where barberry is rare and *Thalictrum* is not as a rule attacked by *Puccinia triticina* Eriks. et Henn., the question of annual recurrence of stem and leaf rusts of wheat is rather complex. Urediospores being short lived and teliospores unable to infect wheat directly, investigators have looked for foci for infection in regions where either barberry and *Thalictrum* are normally attacked or where self-sown wheats occur on which the rusts can over-summer or over-winter as the case may be. Dr. Mehta's investigations conducted under the auspices of the Imperial Council of Agricultural Research have thrown considerable light so far as conditions for annual recurrence in India are concerned. In the Amur region of Eastern Russia, the question seems to have attracted the attention of phytopathologists for some years and a report published in 1927 by Miss A. A. Shitikova-Roussakova (*The Question of how rust infection is introduced into the Amur Region. Material for Mycology and Phytopathology*. Leningrad, **6**, 1927, 13–47) in Russian has recently become available to the writer in translation. For the benefit of rust workers in India, her conclusions are given below where it will be noted that conditions for annual recurrence of rusts on wheat there, are not dissimilar to those existing in India.

Miss Shitikova-Roussakova's conclusions are:

1. Foci for the renewal of stem and leaf rusts in spring do not exist in the Amur region because:
   - (*a*) Owing to severe and snowless winter, only spring wheats are sown, for which reason the rusts do not over-winter either as mycelium or as spores on the autumn-sown wheats.
   - (*b*) Indigenous barberry is met with to such an inconsiderable extent that it does not enter into consideration as an alternate host in causing spring infection with stem rust.
   - (*c*) Although native species of *Thalictrum* are fairly widespread, they cannot ordinarily, owing to dry conditions in spring, be assumed to be the initial cause of infection with brown rust but may only be regarded as a factor serving to enhance the infection in the course of summer.

2. According to the data of 1926 the part played in spring by the alternate hosts (barberry and *Thalictrum*) in renewal of rust in the area of the Amur Experiment Station is very small; there is no barberry and the local æcidial stage on *Thalictrum* develops very weakly in the conditions of drought of 1926.

3. In North Manchuria there exist foci of over wintering rust, from which the latter are introduced by northern wind. The first wave of introduction of leaf-rust and of its infection of the local wheats is indicated as having occurred between the 21st and 22nd of June. The first wave of introduction and infection of stem-rust should be referred to the interval between the 10th and 12th July when winds were blowing from the south.

4. In 1926 the introduction in the area of the Amur Experiment Station of the spores of stem- and leaf-rusts from the wheat-growing districts of North Manchuria was slight owing to the exceptionally severe drought there.

Only after the lapse of one month from the initial importation from the south (namely at the end of July) did the urediospores of *P. triticina* begin to be carried in large numbers by northerly wind: this fact is easily explained by the frequent rain in localities further to the north and by the more intense development there while in the south—in North Manchuria—drought was still persisting and wheat harvest had begun much earlier.

5. Under the condition of drought in 1926, the flight of urediospores of *P. triticina* and *P. graminis* Pers., was small in comparison with that of spores of other species.

6. A sharp increase in the number of spores in the air coincided with the time when all the plants were diseased with an intensity not below 3·25 of the 5 marks scale.

7. The maximum intensity of the flight of the spores of *P. triticina* (as a result of the greatest development of rust locally) occurred at the period of 'waxy' maturity of the grain and the numbers fell off sharply towards the time of harvest owing to the drying of the leaves.

8. The maximum flight of spores of *P. graminis* occurred on 9th and 14th August after which the number of spores sharply

decreased in connection with the beginning of harvest.

9. The late dates in the Amur region of sowing oats which are usually heavily infected with stem rust causes a rise in the curve indicating the intensity of the flight of spores during the autumn months.

10. According to the observations in 1926 the largest number of spores in the air occurred at a height of 2 to 4 metres but closer to 4 metres.

11. The presence in the air of a large number of teliospores of genus *puccinia* and their early appearance are interesting features peculiar to the Amur region and the Primorakaya province.

12. During the night the flight of spores is much less than during the day.

13. The number of spores suspended in the air followed a decreasing curve in the following order: *Helminthosporium, Alternaria, Ustilago,* urediospores of *P. graminis* and *P. triticina,* æcidiospores and teliospores.

A Note on the Rainfall of Kadur, Bangalore and Chitaldrug Districts in the Mysore State.

By N. Rajagopalan.

(*Indian Meteorological Office, Poona.*)

IN his studies on the rainfall of the Mysore State, Mr. Ananthapadmanabha Rao[1] has found a significant linear upward trend in the annual rainfall of Kadur District and an indication of secular trends in the case of Bangalore and Chitaldrug Districts. The data in each case extend over a period of forty years commencing from 1893.

The monthly rainfall data for these districts have been examined by the present writer with a view to find out if there is any linear trend in the monthly rainfall.

Monthly rainfall figures for the forty years were taken from the report on rainfall registration in Mysore.[2] The forty years' data were divided into two equal parts of 20 years each and the mean rainfall for the two periods found out. The months which showed comparatively large differences between these two means were then taken up for closer examination. It is seen that there are comparatively large differences between the means of the two periods in the months of July, August, September, October and November for the district of Kadur, August, September and October for the district of Bangalore and June and November for the district of Chitaldrug. The rainfall series for the above months were then expressed as linear functions of time x, *viz.*, $y = a + bx$, where y represents rainfall, a is a constant and b the regression coefficient. The equations with the values of t for the regression coefficients are given below :—

Months	*Equations*	t
KADUR.		
July ..	$y = 18.14 + .30x$	1.92
August ..	$y = 10.38 + .18x$	2.09
September ..	$y = 5.39 + .04x$	1.02
October ..	$y = 4.80 - .05x$	1.17
November ..	$y = 1.85 + .04x$	1.40
BANGALORE.		
August ..	$y = 4.83 - .036x$	0.92
September ..	$y = 8.17 - .067x$	1.46
October ..	$y = 6.18 - .037x$	0.88
CHITALDRUG.		
June ..	$y = 3.29 - .045x$	3.21
November ..	$y = 1.06 + .055x$	2.04

From the values of t from the above table it will be seen that b, the regression coefficient, is significant for the month of August and approaching significance for the month of July in the district of Kadur, insignificant for the three months studied in the district of Bangalore and significant for both the months in the district of Chitaldrug.

The mean annual rainfall for Kadur, Bangalore and Chitaldrug are 71.87, 31.73 and 23.02 inches with the coefficients of variability 18.49 per cent., 21.0 per cent. and 23.40 per cent. respectively. The analysis of the monthly rainfall shows that the linear upward trend observed in the annual rainfall of Kadur may be ascribed to the increasing tendencies in the rainfall of July and August. For Bangalore, none of the months show any linear trend. The monthly rainfall of Chitaldrug shows a decreasing tendency in the month of June and an increasing tendency in the month of November.

The present investigation was made at the suggestion of Dr. R. J. Kalamkar to whom the writer's thanks are due.

[1] "A Note on the Statistical Analysis of the Rainfall of the Mysore State," by Mr. Ananthapadmanabha Rao.

[2] "Report on the Rainfall Registration in Mysore."

Imperial Agricultural Research Institute, New Delhi.

AN event of outstanding importance to the progress of Agricultural Research in India is the transfer of the Agricultural Research Institute from Pusa to New Delhi. As a consequence of the damage done to the Phipps Laboratory at Pusa by the severe North Bihar Earthquake in January 1934, the decision was taken to move the Institute to New Delhi. Instances of wholesale transfers of big Research Institutes like the Imperial Agricultural Research Institute are rare in the annals of research institutions, not only in India, but also elsewhere in the World and the authorities of the Institute have to be congratulated for the efficient manner in which they have handled the numerous difficult problems that must have beset them in this gigantic task. Their task was rendered all the more difficult by the unusually early break of rains in North-East India and the floods both in Bihar and Delhi which was a feature of the monsoon of 1936.

The Imperial Institute of Agricultural Research at Pusa was inaugurated 30 years ago and with the progress of time became famous in India and abroad as the "Pusa Institute". The Institute holds a proud and enduring record of achievements in the science and practice of agriculture. The transfer has enabled the location of the Institute now renamed "Imperial Agricultural Research Institute, New Delhi" at the Imperial capital, which is easily accessible to provincial agricultural officers, members of the Central and Provincial Legislatures, non-official visitors and visitors from abroad. The foundation stone of the Library Building was laid by H. E. Lord Willingdon on the 19th February 1935 and the Institute was declared open by H. E. Lord Linlithgow, on the 7th November.

The total area of the Institute is about 800 acres, of which about 275 acres are under buildings and pasture and the rest is agricultural land which has been laid out into fields for experiment and research. The buildings comprise a Students' Hostel, providing accommodation for 24 students, separate blocks for the agricultural, botanical, chemical, entomological and mycological sections and a spacious central building for the Library designed to accommodate two lakhs of volumes. The agricultural section situated towards the western boundary of the Institute, consists of two sets, one including a dairy cattle byre with modern fittings, a veterinary dispensary, etc., devoted entirely to the maintenance and development of the pedigree Sahiwal herd. The other set of buildings consist of bullock byres, godowns, a workshop, etc. The main farm area is 475 acres in extent in a compact block for cultivation and field experiment.

In the Botanical section, laboratories have been provided for researches in physiological botany and cytology. In the Chemical section, a laboratory has been equipped for carrying out small-scale investigations on the utilisation of agricultural wastes and products and for devising ways and means for the production of intermediate products from agricultural produce. The necessity for such a laboratory was recognised fifteen years ago by the Board of Agriculture in India. The other features are the provision of a laboratory for nutritional studies relating to the differential composition and nutritive value of the different types of crops and the effect of soil conditions and treatment on the composition and nutritive value of cultivated crops. In the Entomological section facilities have been provided for the study of parasitology. In the Mycological section, there is a large insect-proof house, part of which consists of glassed incubicles for carrying out pot culture experiments.

Post-graduate work at the Institute at Delhi will be carried on with the object of stimulating advanced research in agricultural sciences. The Government of India have recently issued orders that those who have satisfactorily completed the course in any of the subjects, or who may do so in future, will be regarded as Associates of the Imperial Agricultural Research Institute and may affix to their names the abbreviation "Assoc. I. A. R. I."

REVIEWS.

Inorganic Chemistry: A Survey of Modern Developments. By Sir Gilbert T. Morgan and Francis Hereward Burstall. (W. Heffer & Sons, Ltd., Cambridge.) 1936. Pp. 462. 15*s*. net.

This is a most refreshing and remarkable book which no student of chemistry—a category taken to include also teachers of the subject—can afford to ignore. While displaying great variety and wealth of detail it is not a text-book, but rather, as implied by the sub-title, a large-scale picture of inorganic chemistry as it stands at the moment. Excepting fundamental matters required to introduce a chapter or a section, therefore, it deals only with recent events, specific reference to those earlier than the 1920's being rare, and to those in the 1930's very numerous, including many dated 1935.

Such organic chemists as have experienced a difficulty in piloting their course among the shifting sands of modern atomic theories will find the book particularly attractive and helpful. This arises in part from the lucidity with which these theories are unfolded by the introduction, and also because the share taken by carbon compounds in developing modern inorganic theory and practice is constantly brought to mind. Arrangement is based on the periodic system, and before reaching the main groups two chapters deal respectively with the key elements, or zero group, and the isotopes of hydrogen, leading to heavy water. The latter is a valuable synopsis of deuterium chemistry, and will evoke speculation on the bewildering possibilities of deuterorganic chemistry.

In passing through the groups, ample reference is made to co-ordination compounds, as might reasonably be expected from the numerous original observations in this field which we owe to Sir Gilbert Morgan and his collaborators. These are based on the co-ordination and chelate phenomena explained in the introduction as arising from Werner's theory; and have constituted the most potent factor in fusing the organic and inorganic branches which has operated since Wöhler's classical discovery cut them apart. General interest will be taken also in the sections on hydroborons, the rare earth metals, siloxen, hafnium, nitrogen, rhenium, ruthenium, cobalt, nickel and platinum, embracing the most recent information thereon.

Having disposed of periodic groups, the authors devote a long and valuable chapter to the transmutation of elements depending on (1) spontaneous disintegration, (2) artificial disintegration and (3) induced radioactivity. Here will be found profitable information concerning the positron, the neutron, the proton, the hypothetical neutrino and various radiations together comprising the primordial stuff common to all elements. It includes a survey of the uranium, thorium and actinium series of elements undergoing radioactive change, and a long section on induced radioactivity summarising the most recent observations of Curie, Joliot, Fermi and others in this field, with a description of the methods by which artificial transmutation is detected and measured. A fairy-story transformed into reality. Then follows a review of co-ordination compounds in nature, the arts and industries, a special feature of which is the section devoted to their applications in qualitative and quantitative analysis. These have been surprisingly useful over a wide range of metals connected with all the periodic groups, the sensitivity of some colour-tests being almost incredible: one part of copper in one hundred millions, for instance, is detected by sodium diethylcarbamate, and quinalizarin reveals one part of beryllium in ten millions.

The later chapters deal with corrosion of metals, intermetallic systems involving the question whether these are strictly compounds in the modern sense, metallic carbonyls, nitrosyl compounds and finally, organic derivatives of metals and metalloids, covering mercurials, silicanes, germanes, stannanes, arsenicals, antimonials, bismuthines, with carbon compounds of selenium and tellurium, all fully discussed in the light of most recent researches. It forms a becoming conclusion to a work evidently directed to harmonising the carbon with non-carbon fields, and maintains a feature common throughout, namely, unusual care in preparation for the press. This point merits particular praise, because the treatise amplifies three lectures delivered by Sir Gilbert Morgan as recently

as 1933; and yet the proof-reading gives no indication of haste. In fact, the only improvement that can be suggested for future editions is an expanded index.

The foregoing comments will show that chemists now have access to a presentation of chemistry in an eminently unified form. The explanation lies in the fact that throughout his auspicious pursuit of the subject Sir Gilbert Morgan has divided his attention impartially between the two classical branches, and has remained an unflagging devotee of the laboratory; moreover, he has been fortunate to enlist an enthusiastic partner so highly competent as Mr. Burstall.

M. O. F.

Custom is King.—Essays presented to R. R. Marett on his Seventieth Birthday, June 13, 1936. Edited by L. H. Dudley Buxton. (Hutchinson's Scientific and Technical Publications, London.) 1936. Pp. 325. Price 12*sh.* 6*d.* net.

This commemoration volume comprises nineteen essays contributed by Dr. Marett's old pupils and colleagues and presented to him on the happy occasion of his seventieth birthday. The editor has written a brief but excellent account of Dr. Marett's academic life in the first chapter, besides an essay on "The Sea Raiders" which deals with the physical characters of the various invaders who have left marks of their settlement or of their destructive propensities in Oxfordshire. The problem of Buxton is to investigate what kind of man was living in Oxfordshire in Anglo-Saxon times, and was he definitely allied in physical type to the Romano-Britons. The conclusion reached is that the burials of Anglo-Saxons contain two closely allied types of man, one of Continental type, probably pure-blooded invaders, the other more closely akin to the Romano-Britons. It must be remembered that students of history and archæology differ in regard to their views as to the survival of older folk: one school pointing to a fairly complete break at the period of the Saxon invasion, and the other refuting such a break.

In a brief review of this excellent book, we can select only a few essays for comment, without in any way implying that others not chosen for such a purpose are either uninteresting or unimportant. We have read them with great enthusiasm and each essay dealing with a special field of anthropology presents a complete account of the topic.

Anthropology, like other sciences, suffers from specialisation, when it forgets man the animal, and devotes attention to his skull, or his arts and industries or his social customs and manners. "The function of the anthropologist is to interpret man in his entirety—not piecemeal." Earnest Hooton's essay on the "relation of physical anthropology to cultural anthropology" is a powerful plea for a synthesis of these two studies. We entirely agree with the author when he points out that physical anthropology is not a study which can be pursued profitably with utter disregard to its sociological connotation.

The prehistory of the Canadian Indians is another interesting contribution by Jenneso. At the time the French landed at Quebec, they found that the country was occupied by nearly fifty tribes, differing in language and customs, though each tribe was self-supporting. This diversity militated against any serious resistance to European penetration, and has given rise to administrative problems which would not exist, had Canada been inhabited by a single people. These tribes bear strain of many races in their blood. The Mongoloid and Melanesian affinities are traceable among some, and in others those of the white race, which may have spread across Northern Asia during the retreat of the ice sheets. Among these well-defined tribes, the Iroquoian people alone displayed any real talent for political organisation, derived perhaps from their European contact. The principal feature of this organisation was to subordinate village communities to tribal units and to confederate tribes into nations, governed by representative councils and guided by truly democratic ideals.

The book is full of other interesting articles. It seems to us that every cultivated person has an innate interest in the study of anthropology and the book introduces the reader to the rich and varied stores of knowledge concerning the physical and social evolution of the race. The essays form a noble tribute to the genius of a great teacher whose zeal inspired his pupils and whose contributions have enriched the science which he taught.

Ergebnisse der Enzymforschung. Edited by F. F. Nord and R. Weidenhagen. (Akademische Verlagsgesellschaft M. B. H. Leipzig.) Vol. IV, 1935, pages xii + 391, price RM 29; Vol. V, 1936, pages xi + 378, price RM 28·50.

During the past few years the volumes of "Ergebnisse" have formed an indispensable equipment to research workers who find in them a mass of information presented in an easily accessible form and treated in an authoritative manner.

The recent volumes have more than fulfilled the expectations of the students of Enzyme chemistry. They have maintained the high standard set up by the previous issues; they are international in character containing as they do contributions from the foremost workers in the various aspects of enzyme research, irrespective of nationality and are, in a sense, a collection of monographs. Particularly in a subject, in which the knowledge is in a state of flux the contributions of the type covered by the 'Ergebnisse', besides being stimulating and helpful to workers in their particular field of study will prove invaluable to crystallise the momentary position in the various branches and correlate it with advances in other fields.

The fourth volume contains a stimulating article by Henry Borsook on the application of the second law of thermodynamics to the study of enzyme systems. This is followed by a contribution from Henry Tauber on the activators and inhibitors of enzymes. The study of activations, has more recently emerged from its empirical stage and the precise information, now available is of great significance having proved useful in understanding the regulating and directing mechanisms elaborated by the organism: in some cases the study of the activating and retarding systems has thrown light on the nature of the active groups of enzymes and clarified, to some extent, our knowledge of their chemical nature. The activations caused by thiol compounds has been treated by Bersin in a separate article. Other articles are: Cholinesterase by Ammon; Intra-cellular regulation of enzyme-reactions, with special reference to amylase, by St. J. von Przylecki; Application of enzymes in Industry, the second part of which deals with the recent work on the rôle of enzymes in the baking industry by Hesse; Rennet and coagulation of milk by Maurice Beau; Intermediary products of the biological decomposition of carbohydrates by Meyerhoff; Bacterial sugar-fermentation by Kluyer; the biochemical changes during the curing of tobacco (drying and fermentation) by Bodnár and Barta; Animal Dehydrogenases by Harrison; Lactoflavin and enzyme-precursors by Shibata; and Luciferase by Newton Harvey. The volume is provided with a good author index and each individual contribution is provided with a comprehensive bibliography. It is needless to say that in a volume so carefully planned and got up, there can hardly be any error; it is, therefore, surprising to find that on page 29, in the contribution dealing with reversible and reversed enzymatic reactions, it is stated with reference to vitamin C that the "evidence of the existence of this vitamin *in vivo* in a state of partial oxidation, associated with its autoxidisability and its reduction by enzyme metabolite systems, makes it seem highly probable that one of the functions of the substance is to serve as a compliment to incomplete enzyme centres." All existing evidence shows that the autoxidised vitamin C has little physiological significance and only in its partially oxidised state as dehydroascorbic acid is it capable of being reduced to the original state; further no enzyme-metabolite system has been discovered which reduces dehydroascorbic acid, although the existence of such a system has so often been assumed.

Volume V, that appeared more recently comprises 12 contributions, six of them dealing with the enzymes, proteases phosphatases, lacithinases, pectases, glucose oxidase and polyphenol oxidase. There are reviews on recent investigations covering chlorophyll photosynthesis, synthesis of fat from carbohydrates, asymmetric synthesis, optical specificity, autolysis and a contribution dealing with the application of nephelometric technique to enzyme research. Prof. McKenzie's article dealing with asymmetric synthesis is of special interest in view of the biological significance of such syntheses. Among the asymmetrases are *l*-oxynitrilese which brings about the formation of (-)mandelonitrile from benzyldehyde and hydrogen cyanide, carboligase, extensively studied by Prof. Neuberg and ketonaldehydemutase. The section on proteases has been contributed by Grassmann and Schneider and deals with the methods of preparation, purification and isolation of proteases and peptidases. A critical discussion on the nature of proteases and the problems of specificity and mode of

action is included in the contribution. Folley and Kay have given an excellent resume of the recent work on phosphatases which are concerned with the formation and biological functioning of a variety of subtances such as phospholipins, phosphoric esters of carbohydrates, phosphoproteins, phosphocreatine and phosphoarginine, the nucleic acids, etc. Prof. Kertesz has discussed the recent researches on the pectic enzymes, a group which has not received adequate attention; the pectinase complex comprises several specific enzymes such as polygalacturonase, pectin-methoxylase, and arabanase. The author considers that there is need for a comprehensive study of the components of the pectase-complex. The synthesis of fats from carbohydrates has been dealt with by Ida Smedley-Maclean. The production of fats from glycerol and fatty acids is brought about by lipases; the probable mechanism of the production of glycerol is through the decomposition of glycerophosphoric acid produced in the anærobic decomposition of hexose, by a phosphatase; the various theories regarding the production of fatty acids from carbohydrates have been critically examined and the author concludes by saying that the "sum of available evidence at present is probably more in favour of a fatty acid being formed from hexose through the intermediate stage of pyruvic acid than of its formation either directly from hexose or through the intermediate stage of acetaldehyde; but the nature of the steps by which the synthesis is brought about is still to be elucidated." Perhaps the recent technique for the study of intermediary metabolism introduced by Schoenheiner and Rittenberg (*J. Biol. Chem.*, 1935, **111**, 163-192) in which the ordinary hydrogen in the experimental material is replaced by heavy hydrogen and the fate of the altered molecule followed through the organism, may throw light on the problem.

The volumes provide stimulating study. Future annuals will be eagerly awaited.

Chemical Synonyms and Trade Names.—A Dictionary and Commercial Handbook. By William Gardner. (The Technical Press, Ltd., London.) 1936. Pp. 495. Price 31*s*. 6*d*.

In the course of a recent lecture delivered before the Chemical Society, the Editor of the *Journal of the Chemical Society* referred to the long-felt need for systematising the chemical nomenclature and the attempts that are now being made to arrive at an international agreement. While this has been the case even in systematic chemistry, in the designation of chemicals used in trade and commerce, there has been no rationalisation. The names give no clue, whatever, in many cases to their composition, resulting in a great deal of confusion. Some chemicals have been labelled by short names for convenience; others have been called by initials only and for yet others, fanciful terms have been employed. Chemists who have frequently to deal with the trade names of raw materials, pharmaceuticals, minerals, explosives, dyestuffs, alloys and commercial chemicals, should perforce resort to a suitable dictionary. It is difficult to imagine a relationship between the daffodil and cadmium sulphide and yet the term "daffodil" is applied to the pigment which is otherwise called cadmium yellow. There are also numerous instances where the same material is known by different names and this introduces a further complication to the chemist who should provide himself with a dictionary also giving synonyms. The Editor of the Chemical Society in the address, to which reference has already been made, mentioned instances where industrial names have invaded scientific literature; thus the terms *decalin* and *tetralin*, which are the names for decahydro-, and tetrahydronaphthalen, are frequently found in systematic chemistry. The term *thionessal*, which, by the way, is not found in the book before us, is 2:3:4:5-tetra phenyl thiophen. These few instances should be enough to show the value of a compilation of the type under review and chemists should be grateful to the author for having effectively lightened their trouble by providing chemical equivalents of trade names. The fact that the book under review is the fourth edition, shows that chemists have not been slow in realising its value. It contains no less than 25,000 definitions and cross references and is invaluable as reference book, not only to the chemists but also to the manufacturer and dealer. The appendix includes additional matter but the users of the book could have been saved the trouble of having to refer to two separate sections, if the entire matter had been classified alphabetically. This, we have no doubt, will be looked into while bringing out the next edition which, we are confident, the publishers will be called upon to undertake in the near future. The book covers a very wide field and will be

found indispensable to all those interested in chemical industries.

Outlines of Organic Chemistry. By E. J. Holmyard. (Edward Arnold, London.) 1936. Pp. xi + 467. Price 7*sh.* 6*d.*

The fact that since 1924 four reprints and a new edition have been called for, bears testimony to the usefulness and popularity of the book under review. In the 1936 edition large portions have been rewritten and, with exceptions (some of which are noted in the sequel), the material has been brought into line with the latest advances in theory and practice in so far as they may legitimately find a place in an elementary treatise. The historical introduction is fuller than usual, the author being specially qualified to write of this aspect of the subject. The book is readable from cover to cover and the many apt analogies (such as synthetic organic chemistry to a game with Meccano models and steric hindrance to the attempted entrance of a fat lady into a crowded bus) would serve to augment the interest of the beginner in a fascinating, but complex and confusing subject. The theoretical parts (*e.g.*, the chapters on tautomerism and stereoisomerism) are extremely lucid and an adequate account is given of the electronic conception of valency, but since this has become fundamental to the intelligent understanding of organic reactions more space devoted to it would perhaps not be disproportionate. A brief mention might also have been made of the newer physical methods of examining the structure of organic compounds, dielectric constants, the parachor, free energies and the Raman effect. Other sections requiring elaboration are the determination of m.p. and b.p. and microanalytical methods, the time not being far distant when the latter will largely supersede the classical macro procedures. A preliminary insight may also be profitably given into the mysteries of Beilstein-Prager-Jacobsen and Heilbron's Dictionary.

Among the matters of detail that are unsatisfactory, some may be mentioned. The structure of starch and cellulose are by no means "unknown"; nothing is said of modern methods for the dehydration of alcohol and of the fermentation methods for and uses of butyl alcohol; the now commonplace catalytic vanadium pentoxide oxidation of naphthalene to phthalic anhydride and the similar very interesting oxidation of benzene to maleic anhydride are serious omissions; The Diels-Alder reaction needs at least a passing reference even in an introductory volume; while conjugated double bonds are discussed, there is no mention of the technically important butadiene and isoprene; Haworth's name is not cited in connection with the ring structure of glucose; the statement (p. 340) that sucrose differs from glucose in charring with hot sulphuric acid is incorrect, as glucose also chars; the only (nor indeed the main) use for amyl acetate is not as a flavouring essence; all natural glucosides do not give glucose on hydrolysis; acetate rayon is not difficult to dye; diazo salts can be stabilised and in this form are commercial products; among the 200 or more names in the index of names Claisen finds no place.

A work of warning is necessary with regard to the prescription of the book as a text in our Universities. The book stresses the theoretical basis of the subject rather than the practical applications and in the hands of the already theoretically inclined Indian student it would lead to deplorable results unless supplemented by sound laboratory practice and incorporation in the lecture work of the technical aspects of organic chemistry. From this point of view some recent books by American authors deserve wider recognition in this country. K. V.

The Principles of Bacteriology and Immunity. By W. W. C. Topley, F.R.S., and G. S. Wilson. (Edward Arnold & Co., London.) Second Edition, 1936. Pp. xv + 1645. Price 50*s.* net.

We hardly know of any other book on bacteriology which gives a fuller treatment of the subject in all its aspects. The first edition was published in two volumes, and the attempt to combine them into one has swelled the size of the book altogether out of proportion to the conventional avoirdupois of text-books for undergraduate and post-graduate students. But the consolation is that they will find in one volume all the necessary information which recent investigations have added to our knowledge. The greatest merit of this encyclopædic work is that it is eminently readable and none of the blemishes usually associated with technical treatises is encountered in its perusal. We confess, however, that nothing less than the dreadful fear of an impending examination can persuade one to acquire mastery of 1,600 pages of closely printed matter. Having read the book

without the fear of dire consequences of a public examination, we feel that we have read one of the finest text-books, containing a clear, full and authoritative account in each chapter.

The contents of the book are divided into four parts. In these four parts the authors have brought together in the compass of a single volume a multiplicity of subjects which are invariably treated in numerous monographs. The first two parts are devoted to the consideration of the historical and general aspects of bacteriology and systematic account. Parts III and IV deal entirely with general and particular problems emerging from the application of the bacteriological principles to the study and control of infective diseases. These problems are presented in their biological aspects "as instances of variations in the relations of living things to each other, and to their environment, rather than as isolated problems of diagnosis, treatment or prevention, centring round a sick man or animal." The old barrier separating the research workers in human and veterinary science is rapidly breaking down establishing numerous contacts between them and "in no branch of medical science is the sterilising effects of the anthropocentric attitude more obvious than in the study of bacterial infection." The main objective of the authors in following this order of presentation is to provide the student with the knowledge that bacteria constitute a distinct class of organisms in their taxonomical and ecological relations and a knowledge of this department of bacteriological science is indispensable for a comprehensive understanding of their reactions with their hosts. In recent years many bacterial species have been studied solely from their pathological standpoint almost to the exclusion of systematic description. There are gaps in our knowledge of the systematic position of several species, and they have been bridged to the narrowest limits by the personal studies of the authors.

The book has excluded from its compass all detailed descriptions of technique, thus departing from the usual convention of combining practical instructions for laboratory work with the discussion of the general principles of the subject. This breaking away from the routine practice of text-book writers has given the present work a power enabling the reader to acquire a firm grasp of the subject-matter.

At the end of each chapter there is complete list of references to literature so as to afford facilities to the students to follow up for themselves any specific branch of study for fuller information. It is unnecessary to delineate the excellences of this sumptuous volume which is as full of information as it is authoritatively expounded. Bacteriology has interest not only to the medical profession, but it also has an important bearing on agriculture and other industries. A general acquaintance with the principle and the application of this important branch of biological science is almost an indispensable equipment of every cultivated person and the needs of such readers and those of specialists are met by this standard work. It is a monumental contribution to our knowledge of bacteriological science.

Principles of Structural Geology. By C. M. Nevin. (John Wiley & Sons, New York; Chapman and Hall, London.) Second Edition, 1936. Pp. 341. Price 17*sh.* 6*d.*

The second edition of this well-known text-book follows the same lines as the first, with the exception that a new chapter written by E. B. Mayo has been added on the structures associated with igneous intrusion. In common with *Structural Geology* by Willis, much of this book is devoted to a discussion of stress and strain relations, flexures, joints and cleavage; subjects that seldom receive adequate treatment in British text-books. Besides the new chapter mentioned above, the book also discusses structures in unconsolidated sediments, the nature of the earth's crust, continents, oceans and mountain systems. Clear type, good paper and excellent block diagrams, features that have long characterised the geological publications of John Wiley and Sons, give to this book a very pleasing appearance. The binding, however, is unsuited to a monsoon climate.

The book is intended for first year students and is concerned principally with structures in relatively undisturbed sediments. The influence of oil geology is seen in the excellent chapter on flexures. The author is less concerned with the problems of Archæan geology and with complex orogenic belts, in which the effects of metamorphism and violent tectonic movements preclude the deduction of simple causes from effects. Leaving aside these difficult areas of research, attention is paid to simpler structures, and a considerable part of the book is occupied

with the determination of the direction of causal stresses responsible for the formation of given strains; whether they be manifested by joints, cleavage, faults or folds. Even in the case of these simpler structures, however, our understanding of stress-strain conditions is very limited. The author admits (p. 22) that unless it can be demonstrated that the causal stress is non-rotational, its exact direction is usually not determinable. So far as can be seen, however, no indication is given in this book of showing whether or not the stress is rotational. There are so many vicissitudes through which a rock may pass—tensional and compressional stresses, stresses varying in direction in the course of time (p. 58), former burial under a load of unknown magnitude and alteration in ductility,—that the number of inferences from a given deformation is large. This uncertainty is manifest in the chapter on joints (pp. 161–163) where four theories are tested on a single set of observations. It is seen also in the discussion of the stress, shear and strain theories of failure (p. 27). A realisation of this uncertainty is a valuable lesson to the student in caution, but it may be questioned if the qualifying clauses in the general trend of argument really teach it sufficiently. The value of the author's discussion is partly that the reader is taught to visualise structures in three dimensions, and partly that, as an outcome, the solution of certain practical problems, such as an indication of inversion from drag folds (p. 75), is suggested. A chapter of particular interest is that dealing with structures in unconsolidated sediments and the compaction of sediments. In a future edition it is to be hoped that this account will be amplified by a reference to the work of Kendal and Bailey on contemporaneous seismic disturbances. Under compaction of sediments the author stresses the geological results of loss in volume on consolidation. Differential compaction of muds deposited around a hill or chain that is later buried by younger strata results in the formation of supratenuous folds, in which there is a thinning of sediments over the crest of the buried structure. Such folds are considered to be directive in that later folding by compression tends to follow the lines of weakness already established by differential compaction.

In conclusion, this book may be recommended as giving a clear account of the deformation of the earth's crust. J. B. A.

Grimsehl's Lehrbuch der Physik.—Edited by R. Tomaschek. I Volume (Mechanics, Heat, Acoustics). 9th edition. 1936, Pp. 676, R. M. 19·80. II Volume (Electromagnetic field, Optics). 7th edition. 1936, Pp. 900, R. M. 26. III Volume (Matter and Ether). 7th edition. 1936, Pp. 430, R. M. 14. (Publishers: B. G. Teubner, Leipzig, Berlin.)

Grimsehl's Lehrbuch der Physik edited by Professor R. Tomaschek is not new to the English-speaking students of Physics. This work has already become so popular that Messrs. Blackie & Son, Limited, London, have issued an authorised translation in a series of five volumes, the last volume of which has been published only very recently. The latest German edition of this work, which is in our hands, has been issued in three volumes. The first volume dealing with Mechanics, Heat and Acoustics being the ninth edition, while the other two volumes dealing with Electromagnetic field and Optics, and Matter and Ether are the seventh German editions.

A perusal of this work reveals the comprehensive nature of the undertaking. Even the subject-matter has been so arranged that the trend and continuity of thought have been kept up throughout. Another characteristic feature of this didactic masterpiece is the numerous illustrations (many of them being clear reproductions of actual photographs) which adorn almost every page. The advantages of such illustrations as an aid to the understanding of the subject-matter need hardly be stressed. Special mention must however be made of the beautiful photographs reproduced in the second volume illustrating the laws of Geometrical Optics. This has transformed the usually dry subject of Geometrical Optics into a very lively topic. As the editor himself remarks, the experimental facts are consistently kept in the foreground and the theory developed only so far as is needed to explain the experimental results. Another added feature is the inclusion of a set of tables containing Physical Constants and other relevant data which are of immense use to the student. The treatment has been uniformally good so that we cannot pick out any particular chapter as having been the best of the lot. The editor has tried to make the work as up to date as possible and considering the rapid pace at which scientific research is developing it is imperative that one or two

of the latest discoveries might have been omitted and it is not fair to criticise the work on that score.

Before concluding a word of praise must be given to the excellent get-up of the publication which is a characteristic feature of most of the German publications. We have no hesitation in recommending this work as a text-book in all colleges in which Physics is being taught. B. V.

A Text-Book on Astronomy. By H. Subramani Aiyar, M.A., Ph.D. (London). (Chitra Publishing House, Trivandrum.) 1936. Pp. 438. Price Rs. 6-12-0.

This volume, as explained by the author in his preface, has been specially prepared to meet the demand for an introductory text-book for the use of students taking a course in those portions of astronomy that are required for the B.A. and B.Sc. degrees in Indian Universities. Dr. H. Subramani Iyer is peculiarly fitted for the task of writing such a text-book, from his long experience as a teacher of astronomy in the college classes and also the Director of an old established astronomical institution. Astronomy is studied in most of our universities as a part of mathematics and hence the treatment in this book is, to a large extent, mathematical. The course well covers the academic requirements even up to the honours standard, the mathematical portions following closely the well-known treatises of Godfray, Ball and Smart.

The main part of the book is devoted to spherical astronomy and has many features to commend it. The principal facts are here presented in a clear and concise manner so that even readers with only a limited equipment of mathematical knowledge can understand the essential principles of the subject. The book opens with an introductory chapter dealing with the sphere where the fundamental formulæ of spherical trigonometry, required in the later chapters of the book, are derived. Chapters II to V deal successively with the Celestial sphere, the various systems of spherical co-ordinates, the figure of earth, the phenomena depending on the earth's diurnal rotation and its annual revolution round the sun. A brief introduction to the elementary principles of dynamical astronomy is given in Chapter VI which is followed by a chapter on time and the different systems of time reckoning. Chapter VIII is devoted to the various methods employed for finding local time and for determining the co-ordinates (latitude and longitude) of a place from observations. In the next four chapters, the important corrections to astronomical observations are discussed—*viz.*, Precession and Nutation, Aberration, Refraction and Parallax. The moon, the planets and their motions form the subject of the next two chapters. Chapter XV deals with the transit of an Inferior Planet across the sun's disc, which, it has to be observed though good as a mathematical exercise, now possesses little more than a historical interest. We have next an excellent chapter on Eclipses, but a fuller treatment of occultations and the methods of reduction would be desirable.

Passing on to the descriptive portions of the work (Chapters XVII and XVIII) we have to confess a feeling somewhat of disappointment. The account is too brief and does not form a well-connected story. Perhaps it is due to the fact that the author has attempted to condense an enormous amount of information on a growing subject within a space of thirty pages. The arrangement of matter in the chapter on "Stellar Universe" does not seem to rest on a logical basis. Occasionally we find references to peculiarities of spectra but nowhere do we find a clear description of the laws of spectrum analysis, the spectra of stars and their classification. It is hoped that in a later edition the author will take the opportunity to revise these two chapters and place them on a level with the other parts of the book.

Space does not permit a detailed discussion of the several topics which might have been included. There are some typographical errors and occasionally a loose statement is met with. As an example we may quote the passage in page 322 "Thus Sirius was known only to be a spectroscopic binary until.... ". It is a well-known fact that the existence of the companion was predicted from the periodic variations in the proper motion of Sirius first by the researches of Bessel and later on of Auwers, long before A. G. Clark discovered the star by visual observation.

The diagrams illustrating the text appear to be carefully drawn, but the photographic reproductions leave much to be desired. A few typical photographs selected from the collections of the great American Observatories will add much to the value of this part of the book.

The chapter on "Thirty Constellations" forms interesting reading and cannot fail to

be of assistance to the beginner in astronomy in studying his sky. In the next chapter, (Chapter XX) we find a good description of the principal astronomical instruments, their uses and also a discussion of the chief sources of error they are subject to and the usual methods of adjustment. There is a collection of examples at the end of the book and a set of appendices and tables useful to the student of practical astronomy. If one may venture a suggestion, a few worked examples in the body of the chapter would be helpful to the reader in understanding the text.

The volume is to be commended on the whole, as a laudable attempt by the author to combine the general features of a standard text-book on spherical astronomy with a brief resume of the principal facts of descriptive astronomy. T. P. B.

The Diseases and Pests of the Rubber Tree. By A. Sharples. (Macmillan and Co., London.) 1936. Pp. xvii + 480. 25*s*. net.

This is quite distinct from Petch's book of the same name also published (in 1921) by Messrs. Macmillan, and advertised on the wrapper of the present volume as still being on sale.

The manual now published represents a welcome and up-to-date account by an acknowledged expert, who since 1913 has specialised in the pathology of *Hevea brasiliensis* under Malayan conditions.

Of the 480 pages comprising the book, Part I. (45 pp.) is devoted to general remarks on plant diseases, with special reference to those of the rubber tree. This part is well written and is justified in a book intended largely for use by planters. The discussion on pp. 10 and 11 as to when a mycologist ceases to be a mycologist and becomes a plant pathologist is largely a matter of words, the facts already being fairly obvious.

Part II. (19 pp.) gives a sketch of certain aspects of plant anatomy and physiology, and in the reviewer's opinion, might well have been omitted, as it seems somewhat out of place and is too elementary and condensed to be of any great value.

Part III, the remainder of the book, is devoted to diseases and pests.

Root diseases (pp. 75–207) are very fully treated. Recent work on the morphology of *Sphærostilbe repens* is described. Views of the *Fomes* types of root-fungi have changed considerably of late years; spread through the soil occurs through root contact, and the essential control measure is complete removal of infected jungle timber.

Tapping panel diseases occupy pp. 208–65, and include full descriptions of Mouldy Rot (*Ceratostomella fimbriata*), and Brown Bast disease (physiological). On p. 243 the identity of the Black Stripe organism *Phytophthora faberi* Maubl. with *P. palmivora* Butl. is admitted; *P. meadii* McR. and *P. heveæ* Thompson are here given as separate species, though recent investigators agree in regarding them as also synonymous with *P. palmivora*. On pp. 313–14 the old name *P. faberi* is again used.

Among stem diseases, the most important in Malaya are Pink Disease, stem *Ustulina*, and *Diplodia* Die-Back. Leaf Fall due to *Oidium heveæ* is best controlled by sulphur dusting. Miscellaneous matters such as lightning damage, sun-scorching, abnormalities, and spotting of prepared rubber are fully dealt with.

Insect diseases (pp. 369–413) appear to be dealt with comprehensively, special attention being devoted to white-ants and cockchafer grub.

Remaining chapters deal with Animal Pests, Forestry Methods of Cultivation and Treatment of Disease. A well-justified warning is given on p. 430 against the touching faith of manufacturers in the Rideal-Walker standardisation as applied to fungicides.

An Appendix gives a useful list of all the fungi, parasitic or saprophytic, that have been recorded on rubber trees in Malaya.

The book is well illustrated, the microphotography being particularly good and misprints and slips are rare. One misprint which may be mentioned, since it appears in almost every mycological paper published in India, (although noticed only once in the present book), is "casual fungus" on p. 295 for "causal fungus"; another still more universal error is the misuse of the word "fungoid", *e.g.*, on p. 9. A fungoid growth is not a fungal growth, but a growth that merely *resembles* a fungus—the "cauliflower ear" of a pugilist, for example, may correctly be termed fungoid, but a specimen of *Hirneola auricula-judæ* may not.

L. D. GALLOWAY.

Theory of Lubrication. By M. D. Hersey. (Chapman & Hall, London; John Wiley & Son, New York.) 1936. Pp. x + 152. Price 12*s*. 6*d*.

Lubrication is essentially a practical problem. However a theoretical understanding of

the problem and its applications have a great effect on the design and operation of machinery, reduction of space occupied and the power utilised as also the lengthening of the life of the bearing surfaces to a great extent.

"Lubrication like every other mechanical action is governed by Newton's Laws of Motion upon which the science of mechanics is based. Sir Issac Newton (1687) discovered the fundamental laws of viscous resistance underlying the theory of lubrication according to which shearing stress is proportional to the rate of shear." On the basis of this concept the author shows the difference between liquids, non-Newtonian liquids and plastics. Petroff's equation and the Poiseulle's law have been derived as examples of applications of Newton's law. "It appears that for any given bearing, the frictional torque is proportional to the viscosity of the lubricant and the speed. For bearings of the same diameter with different shape factors, the torque is directly proportional to the length and inversely as clearance. For bearings of different sizes but geometrically similar, the torque is proportional to the cube of the absolute size."

"When a film is not of a uniform thickness there will be a positive fluid pressure developed in the converging portion of the film, as pointed out by Reynolds. This pressure supports the load, floats the journal or other moving surface and under favourable conditions entirely prevents metallic contact." Chapter III deals with the mechanical phenomena in the film, leading to the derivation of Reynolds' equation for the pressure distribution in the film (under steady running conditions with an incompressible lubricant) based on the general equation of the hydrodynamic theory. Full integration of the Reynolds' equation by Sommerfeld, Michell Stodola and others including the electrical integration by Kingsbury are given at length.

"The most evident limitations of the hydrodynamic theory in its present state of development and application may be considered under three heads: (1) The point of view of analysis; (2) Physical limitations; and (3) Geometrical limitations."

"1. Some of the most ingeneous and successful investigations such as Kingsbury's ...... have been conducted strictly from the view-point of bearing design. The results therefore are not directly applicable in calculating the probable performance of a bearing of any fixed design, or in selecting the most suitable lubricant for existing machinery."

"2. The treatment is usually limited to a steady state with constant viscosity and in most investigations, even when side leakage is taken into the picture, the effects of negative pressure are dealt with in some arbitrary and artificial way."

"3. The bearing surfaces are assumed perfectly smooth and rigid and of some ideally simplified geometrical form; the applied loads other than the driving torque, reducing to a single resultant force, conveniently located for purposes of calculation."

Because of these limitations under experimental conditions "the number of observations necessary for exploring the field in connection with any one type of machine element may be very considerable and the expense correspondingly great, when separate factors are varied over full range one at a time."

These difficulties are sought to be overcome by the combined mathematical and the experimental approach of the dimensional theory outlined in Chapter IV. This theory has been developed from elementary principles and it is shown that the results of this theory in comparison with those of the classical hydrodynamic theory bears no inconsistency. "The dimensional theory provides a partial mathematical solution for problems that are too complicated to be dealt with by the more usual methods of integrating of differential equations."

After considering the problems arising out of temperature rise in the bearings the author takes up the problem of oiliness in Chapter VI. "A condition known as imperfect lubrication will be introduced when the load is too great, the speed or viscosity is too low, the rubbing surfaces held parallel or the quantity of lubricant insufficient. This condition can be almost avoided under modern methods of designing and operating bearings, though it is difficult or impossible to escape in the operation of heavy duty gears and cutting tools. Even in case of journal bearings which appear to be correctly designed (so far as can be judged from the blue print) excessive loading may be caused locally on small areas due to misalignment, roughness, or elastic and thermal deformation. The well-known phenomena associated with oiliness, wear, and seizure then take place." Various definitions of oiliness which are vague in themselves are given. Oiliness may be considered as a

property of the oil or the joint property of metals and oils. Herschel uses the word oiliness and defines it "as the property that causes a difference in the friction when two lubricants of the same viscosity at the temperature of the film are used under identical conditions." This admits of no difference between oiliness and viscosity. However no one definition seems to be wholly satisfactory. "Regrettable confusion tending to retard technical progress might be caused by the indiscriminate use of the term *oiliness* for any and all meritorious characteristics of a lubricant." In conclusion various hypotheses (like those of plasticity, bulk effects, intensive viscosity, adsorption, adhesion and stratification) for oiliness are mentioned.

The author has kept close to his theme of a theory of lubrication and has scrupulously avoided experimental side and such other explanations which might form a digression. A condensed treatment has been achieved at the expense of possibly more interesting details. The mathematical details have been clearly worked out; and after a certain stage the author does not fight shy of taking aid of qualitative reasoning for drawing relevant conclusions.

However certain very elementary things like the conversion tables in pages 31, 102 and the dimension tables like those in pages 76 and 95 might have been conveniently transferred to an appendix at the end of the book.

While dealing with oiliness one expects a more detailed treatment of the recent works of Hardy, Langmuir and others on film and boundary lubrication, than a mere passing reference.

Every chapter contains a list of complete and up-to-date references of its own and the text is fully punctuated with reference numbers. The author in his introduction refers to the book as a key that might open the box containing a bunch of keys (references). Unless the "keys" are presented in a more attractive fashion and their relative values exposed, though at the cost of condensed treatment, there may not be enough inducement to make use of them.

The book is nicely printed and got up well.

B. S. SRIKANTAN.

Morphology of Vascular Plants: Lower Groups (Psilophylales to Filicales). By Eames, Arthur J. McGraw-Hill Publications in Agricultural and Botanical Sciences. (McGraw-Hill Book Co., Inc., New York and London.) 1936. Pp. xviii + 433. 24*s*.

Morphological literature on the vascular plants has been accumulating so rapidly during the last few years that both teachers and students have keenly felt the need of a suitable book in English to supply this information in the form of a connected narrative. The reputation of the author as a lucid and interesting writer is well borne out by his previous book on "Plant Anatomy" written in collaboration with Dr. L. H. MacDaniells. That this work, like the last one, should be quite in touch with the present state of our knowledge on Pteridophytes, was of course expected of its author and this expectation has been fully justified.

The view-point is that of "broad comparative study, with the development of a natural classification and phylogenetic relationships as the goal." Emphasis has been placed on the range of structure within a group rather than on cytological and anatomical details about individual forms. The treatment embodies the whole of the Pteridophytes or "Lower Vascular Plants," as the author prefers to call them.

The first chapter deals with the Lycopodiaceæ, although it may perhaps have been more logical to start with the Psilotaceæ which are now regarded as the simplest living Pteridophytes. The second deals with *Selaginella* and calls attention to several important features not described in other text-books. With regard to the morphology of the rhizophore, the author states that they "appear to be modified stems", a view which can hardly be justifiable on anatomical grounds. The reviewer is inclined to consider them in the nature of aerial roots, which bear other roots immediately on touching the ground, as in some spp. of *Ficus* and *Tinospora* (see also Uphof, *Ann. Bot.*, 1920). The Bibliography on this genus calls attention to several important papers that have appeared recently. To these may well have been added the work of Wardlaw on its anatomy and Geiger on the development of the megagametophyte, fertilisation and appomixis.

Chapter III gives an excellent account of the problematic genus *Isoetes* and IV deals with the Psilotales. Ford's secondary xylem elements at the base of the stem have been considered (and perhaps quite correctly) as centrifugally developed cells, so that the xylem is mesarch in this region.

The next chapter deals with the Equisetales

and is concluded with a brief but illuminating comparison of the forms dealt with so far. Rumberg's excellent work on the prothallia of *Equisetum* (*Planta*, 1932) has perhaps escaped the notice of the author.

Chapters VI to XIII deal with the Filicales. Teachers will always turn to Bower's classical work on this order for detailed information but from the student's point of view we have here an admirable and logically organised mass of facts on the group. The next three chapters describe the Fossil Pteridophytes and the last gives an account of alternation of generations and classification of vascular plants. The volume is concluded with a useful Index of 21 pages.

There is a total of 218 figures, admirably executed when original, and well selected where they have been borrowed. Those engaged in teaching this group will probably lament the passing away of some old friends, but in general the author is to be congratulated on his choice.

It is difficult, where all is so good, to point out the best. We are so charmed by Prof. Eames' account of the life-histories that we are less ready to forgive him for the abbreviation of many anatomical details, especially on *Selaginella* and Filicales.

P. MAHESHWARI.

Die Verbreitung der hoheren Wasser pflanzen in Nordeuropa (Fennoskandien und Danemark). By Gumnar Sammelsson. (Acta Phytogeographica Saccica VI., pp. 1—211; 50 figs.) Upsala, 1934.

In this monograph the author has discussed the results of his studies on the distribution of the higher plants of Northern Europe (Finland, Scandinavia and Denmark) which he commenced in 1919 and has continued since then.

The author has recorded on maps, accompanied by lists of localities, the distribution of all the aquatic species present within the area. Forty-seven of these have been included in the monograph and the author's conclusions are mainly based on them.

The total number of species investigated is 149, of which 6 are typically salt-water and 19 are brackish and fresh-water species; of the 135 fresh-water types, 110 are submerged and the rest are amphibious.

The author's conclusions are contained in the last three chapters, which deal with the effects of climate (Ch. IV), soil and water types (Ch. V) on the distribution of aquatic plants, together with the history of immigration of the types into the area (Ch. VI).

The author ascribes the present-day distribution of species mainly to the long-continued operation of ecological factors (climatic as well as edaphic) and is very critical of the tendency to ascribe it to the working of hypothetical factors such as previous wide distribution of the species, their relict nature, and their wanderings before making a careful analysis of the working of the ecological factors at work to-day. The author attaches great importance to the nature of the locality in determining the distribution of various species. Depth of water, the structure of the soil, the movements of water (currents, etc.) and its chemical composition are all recognised as having great influence on the occurrence of particular species. In addition, the Biotic factors such as the competition of the various species among themselves, the capacity of particular species to produce favourable conditions for the growth of others (*e.g.*, those which only grow in quiet areas or in clear areas between thickets of another), the influence of lower organisms on the composition of the water (particularly its oxygen content and temperature) are all considered from this point of view.

For a discussion of the history of immigration of the species the author utilises the results derived from a study of the fossil flora of the quaternary strata.

He comes to the conclusion that at least the most common aquatic species of South Sweden have migrated into it from the South soon after the melting of the land ice before the end of the Ancylus period.

The history of the Norwegian flora is not so well known, but it is assumed that it dates from the boreal period. As regards Finland the author is of opinion that in South and Central Finland an aquatic flora existed similar to the flora of South Sweden of the same period. The author considers that changes of climate which are known to have taken place in post-arctic times must have influenced the distribution of aquatic types very considerably. The steadily contracting northern limit of Trapa and other genera prove this. A steady cooling of the climate set in during the transitional period from the Bronze to the Iron Age. The climate became not only colder but also markedly oceanic. This led to progressive changes in the habitat which favoured

particular species at the expense of others. The present-day distribution may, therefore, be regarded as resulting from the interaction of the sum total of the environmental factors on the plants themselves.

The monograph itself must be consulted for details.

S. P. A.

Cinématique des milieux contimus. By Ch. Platrier. (Actualités Scientifiques ee Industrielles, No. 327.) (Hermann et Cie, Paris.) 1936. Pp. 34. Price 8 *fr*.

This volume is the third of a series of three books written by the author on the science of kinematics. This is a small book of thirty-four pages and of three chapters, dealing with the kinematics of continuous media. The first chapter gives an account of the continuous transformation, deformation tensor and its main properties, while the second chapter is devoted to infinitely small deformations and the third one deals with the methods of Lagrange and of Euler in the kinematics of deformable bodies. The book covers the major part of the subject-matter treated in the chapters 32 and 33 'Traite de Mecanique Rationnelle', tome troisieme by P. Appell. The subjects are treated with remarkable conciseness and lucidity and the author has succeeded in conveying much information in a small space.

M. N. N.

Phenomnèes photoèlectriques et leurs Applications. Par G. A. Boutry. I. Phenomènes photoémissifs, Pp. 100. Price 20 *fr*. II. Cellules photoémissives, Pp. 59. Price 15 *fr*. III. Photoconductivité, Pp. 84. Price 20 *fr*. IV. Différences de Potentiel photoèlectriques, Pp. 51. Price 15 *fr*. V. Photométrie photoêlectrique (Mesure des Courants), Pp. 51. Price 15 *fr*. VI. Photométrie photoêlectrique (Mesure des Flux), Pp. 72. Price 15 *fr*. (Nos. 312, 313, 336, 337, 345 and 346 of Actualités Scientifiques et Industrielles. Hermann et Cie, Paris.) 1936.

It is remarkable that two discoveries like that of the electromagnetic waves and of the photoelectric effect which led physicists to exactly opposite conclusion regarding the nature of light should be associated with the name of one physicist, *viz.*, Heinrich Hertz. It is equally remarkable that both should have developed into extensive branches of applied physics associated with mighty industries like radio, talkies and television. The simplicity and beauty of Einstein's explanation of the photoelectric effect is all that we see in the ordinary text-books. But what variability and complications are associated with the phenomenon can only be appreciated when we delve into the details. The books before us give a finely balanced and impartially critical resumé of the facts in this maze of secondary effects. The presentation is elegant and inviting. The limitations of the results so far achieved are indicated and suggestions for further investigation are judiciously thrown out. The bibliograpy at the end of each chapter contains critical remarks on each paper and is a very valuable guide. The emphasis is on the experimental side but the relevant theory is introduced wherever necessary. Apart from a description of the various types of photoelectric cells, methods of measuring the currents, methods of amplification necessary for most purposes, photoelectric relays and so on, there is no account of technical or industrial applications as such. On the other hand the various properties of cells and the different methods of measurement common to all applications are the objects of description.

Within these limits, however, the account is detailed and full. The titles of the several volumes give a correct idea of the contents so that we need not elaborate this side of our remarks. In some places the description is rather short and not quite clear. Thus in I, pp. 21 and 22, in the description of Fig. 13 the letters A and S are mentioned but are not to be found in the figure. So also in III, pp. 9 and 10, the regions (1) and (2) referred to in the text are not marked in the corresponding diagram. There are also a few misprints here and there. The books on the whole, however, can be unrestrainedly recommended to all who require a just view of an important subject full of intricacies in the details.

Théorie de Diffuseur (Haut-Parleur sans Pavillon). Par F. Bedeau (No. 281 of Actualités Scientifiques et Industrielles.) (Hermann et Cie, Paris.) 1935. Pp. 67. Price 15 *fr*.

This is a clear and readable account of the construction and working of the moving coil loudspeaker of the type designed by Rice and Kellogg. The theory behind the details of the design is dealt with in detail. The explanation of the theory as *e.g.*, the idea of acoustic impedance is illuminating. The numerical example on pp. 50–53 brings the theory home in a concrete fashion. There are a number of obvious misprints, *e.g.*, on pp. 18, 23, 25, 30, 34, 36, 46, 50, 60

and 64. On p. 7 it is not stated how the line CK in Fig. 3 is to be drawn. Apart from these minor defects, the book provides a good account of the design and testing of a moving coil loudspeaker and may be recommended.

Le deuxième Theorème de la Thermodynamique et la Mécanique ondulatoire. Par Satosi Watanabe. (No. 308 of Actualités Scientifiques et Industrielles.) (Hermann et Cie, Paris.) 1935. Pp. 93. Price 20 *fr.*

The book represents an attempt to provide for the second law of Thermodynamics a rigorous and logical foundation based on wave mechanics. The method of Carathéodory has been modified to suit the new mechanics. Classical conceptions such as extension in phase space have been eschewed and a systematically quantum mechanical viewpoint is maintained. However, the author has had to resort to what he calls "the thermodynamic criterion," *viz.*, the proposition that "A thermodynamic state cannot be divided into more than one thermodynamic state by an adiabatic transformation." The subject is difficult, and, as L. de Broglie says in his preface, "the book must be read carefully." When this is done the reader will encounter very keen reasoning which almost leads to conviction; the rest must be left to the judgment of much more competent critics.

Reaction Topochimiques. Part I.—Generalites; Part II.—Le Nitration de la cellulose; Part III.—Le Gelatinisation des Nitrocelluloses. By Marcel Mathieu. (Actualités Scientifiques et Industrielles. Nos. 315, 316 and 317.) (Hermann et Cie, Paris.) 1936. Price 12 *fr.* each.

The compounds formed by the polymerisation of simple molecular groups, such as the paraffins, the polysaccharides, etc., present characteristics which are often difficult to interpret with the usual chemical or physico-chemical laws. Apart from the reactions in which the molecular structure is broken down as in the hydrolysis and splitting of molecules, an important characteristic of these complexes is the several reactions to which they can be submitted while conserving in general their crystalline structure. Such reactions go under the general name of 'topo-chemical' reactions. A typical example is the nitration of cellulose, where the NO_2 groups replace the reactive OH groups in the cellulose molecules continuously with very little change in the lattice-structure. These topochemical reactions which take place in the molecular edifice itself, have the characteristic of a solid solution. They play an important rôle in the phenomena of assimilation by living organisms and in the changes taking place in living tissues.

M. Mathieu has presented in these three monographs a very interesting and readable account of the studies on cellulose, and of the classical works of Astbury, Meyer and Mark, Bragg, and others. The monographs can be warmly recommended for all those interested in the structure and reaction of highly polymerised compounds such as the polysaccharides, the polyprenes, the proteids and the bakelites. M. A. G.

The Problem of Nutrition. Published by the League of Nations. Vol. I, Interim Report of the Mixed Committee; Vol. II, Report on the Physiological Bases of Nutrition; Vol. III, Nutrition in Various Countries; and Vol. IV, Statistics of Food Production, Consumption and Prices.

These four Reports are the result of the action of the 1935 League Assembly, which set up a "Mixed Committee," including agricultural, economic and health experts, to prepare a report on nutrition, and instructed the technical organisations of the League to "collect, summarise and publish information on the measures taken in all countries for securing improved nutrition." Vol. I is a general report which may profitably be read in conjunction with the International Labour Office Report *Workers' Nutrition and Social Policy.** It is a preliminary report, and its conclusions and recommendations are tentative. The need for educating the medical profession, its auxiliaries and the general public, in the newer knowledge of nutrition is strongly emphasised. Of other recommendations, the following are of particular interest:—

"Governments should consider what steps should be taken, whether at the public charge or otherwise, to meet the nutritional needs of the lower-income sections of the community, and, in particular, the means by which they might ensure that an adequate supply of food, especially safe milk, should be made available for expectant and nursing mothers, infants, children and adolescents.

* "Studies and Reports Series B (Social and Economic Conditions)," Geneva, **1931**, No. 23.

"Governments should consider whether any modification of the general economic and commercial policy is desirable in order to ensure adequate supplies of foodstuffs, and in particular, to assist the reorientation of agricultural production necessary to satisfy the requirements of sound nutrition."

One recommendation is of interest to those concerned with nutritional problems in India: The Mixed Committee "invited the assembly to recommend the governments concerned to give their full support to the Health Organisation in its enquiries into the widespread malnutrition which exists in the tropics and certain Far Eastern countries."

The present report, drawn up by a committee including experts of varying nationality and outlook, is in places somewhat ponderous and platitudinous. Nevertheless it does adequately define the problem of nutrition in relation to public health and state activity in general, and indicates the lines which must be followed if the discoveries of modern nutritional science are to benefit mankind in general.

Vol. II contains a revised version of a Report† issued in December 1935, in which optimum dietary requirements were defined in terms of foods and food factors. It sets up the objective to be striven for by conjoint effort. In addition to the diet schedules for pregnant and nursing women, infants and very young children given in the first report, schedules for children 5–7 and 12–14 years of age are included. There is a good definition of what is meant by "protective" foods, and a more detailed account of calorie and protein requirements. Doubtless this report will meet with some technical criticism on the part of nutrition workers and will need modification from time to time, but in general its recommendations are sound as far as present knowledge goes, and it will adequately fulfil the purpose for which it was drawn up.

In Volume III one finds a mass of valuable and hitherto quite unavailable information about public health nutrition work in some 27 countries. The chief activities dealt with are the following :—

- Measures taken on behalf of mothers and infants.
- Measures taken on behalf of children of school-age and young people.
- Measures taken on behalf of adults, and in particular of unemployed adults.
- Army and Navy dietaries.
- Measures to enable particular categories of consumers to obtain foodstuffs at reduced prices.
- Measures for ensuring the quality of foodstuffs.
- Research, education and popular instruction with regard to food values.

It is surprising to note how much is being done throughout the world under these various heads. One must, it is true, remember that the data in the report were supplied by government departments in each country, and there is a natural tendency to make the best display possible. But in general it appears that governments are becoming aware of their responsibilities in connection with the feeding of populations. The Report, 271 pages in length, will be a useful reference work for those concerned with practical aspects of nutrition. The fact that advances are being made in this field elsewhere in the world, even in very poor countries with large peasant populations, should stimulate the study and attack of the problem of nutrition in India.

Vol. IV, "Statistics of Food Production, Consumption and Prices," has been prepared by the International Institute of Agriculture, Rome. The first 36 pages provide a general summary of production and consumption trends, and the remainder of the Report is devoted to appendices containing Tables of Production and Consumption, Price Index-numbers, etc. The International Institute of Agriculture was asked by the Mixed Committee to pay particular attention to what are sometimes known as the "protective" foods, but the first sentence in the Report indicates the difficulty of complying with this request. "Statistics of production, in any country, of the protective foodstuffs—milk and its derivatives, meat and fish, eggs, fruits and fresh vegetable—are notoriously unsatisfactory. Relatively few countries ever attempt to compile annual estimates of complete national production: hardly any of those that do make the attempt would care to claim more than a very moderate degree of accuracy in the figures they compile." Nevertheless, in spite of the defects in the available data, it has been found possible to reach some general conclusions in the case of 16 European countries, the United States, Canada, Australia and New Zealand.

† C. H. 1197, Geneva, 1935.

Production of milk is, in general, increasing in these countries. Butter shows the same upward trend, which has, however, been slightly checked in the last year or so. In some countries which are largely exporters of butter and cheese production has diminished, a compensatory rise being visible in countries which are normally large importers of these foods, and which are now seeking to develop home production. Meat production is, in general, rising, but here again a check is visible in the great meat-producing countries—*e.g.*, Australia. The trend of the production of eggs, fruit and vegetables is also upwards. Consumption in most cases runs parallel with production and it thus appears that the quality of national diets in Western civilisation is improving.

An interesting section is that dealing with "Measures of Financial Assistance to Agriculture." Methods followed in the United States under the Agricultural Adjustment Act (A. A. A.) have been particularly striking. The government adopted the policy of buying live-stock from the farmers to relieve congestion and to raise prices, but this was not simply destroyed and lost to the nation; the "surplus" food so obtained was largely handed over to unemployment relief organisations, or made available for improving the nutrition of school children, etc. The commodities purchased and handed over to unemployment relief agencies included dairy products and sugar. The government spent 204 million dollars in this way in two years, but of this 187 million dollars were recoverable advances to government relief organisations. The A. A. A. has now been pronounced "unconstitutional" by the Supreme Court, a remarkable example of how the development of government on modern scientific lines may be checked by an outworn eighteenth-century constitution.

All these reports will repay careful study on the part of scientific, medical and public health workers in this country. W. R. A.

Indian Science Abstracts. (Being an annotated bibliography of Science in India.) Published by the National Institute of Sciences of India, 1936. Price Rs. 7–8–0.

The number of active centres of research scattered in different parts of India and their scientific output have been increasing at a rapid rate during the past decade or two. The need has been increasingly felt for a collection of the scattered scientific literature of the country, which would help in avoiding duplication of work at different centres and also offer the results obtained at one centre early enough to workers elsewhere, interested in similar or allied problems, to be of advantage to them. The increase of literature, especially in the biological sciences, was felt to such an extent that the Society of Biological Chemists (India), soon after its inauguration, undertook the publication of an Annual Review of *Biochemical and Allied Research in India*, the first number of which appeared in 1931.

The attempt on the part of the National Institute of Sciences of India to publish an annotated bibliography of scientific literature in India under the caption of *Indian Science Abstracts* should therefore be welcomed as opportune. Such a publication, however, if it is not intended merely to serve as a record of Indian achievements in Science but prove of any help to the research workers in India, should aim at certain requirements such as completeness, quality and earliness of publication.

Considering the comprehensiveness of the sciences taken up for abstracting, which range from Astronomy and Anthropology to Metallurgy, Palæontology and Zoology, it would have been fortunate if the editors could have secured the co-operation of existing scientific societies in India specialising in particular fields to undertake the editing of the parts relating to their respective spheres. In fact, instead of having the abstracts belonging to widely differing subjects all under one cover and charging a high rate for the whole, it would have been better if the parts had been issued separately. It is rather surprising that the editors have not thought fit to number the pages, as such numbering would have facilitated references to the abstracts.

The volume purports to be Part I for the year 1935, but it is not stated whether the subsequent parts would cover the same ground or other subjects not included in the present part; if the former, one may ask why the publication could not have been delayed till the fresh matter could also be incorporated, as it would have simplified alphabetical classification and subsequent reference to the contents; and, if the latter, the volume is incomplete and does not do justice to the great volume of literature that has been issued in India on the subjects covered. Continuity of quality and comprehensiveness of matter abstracted could best be secured through an efficient agency of workers organised on a business footing and preferably acting under the guidance of specialist scientific societies. C. N. A.

Correlation of the Ancient Schistose Formation of Peninsular India.*

IN Part I of this memoir, reviewed in the September number of this Journal, Sir Lewis Fermor divided the Archæan rocks of India into regions and provinces for purposes of description. No. 1 of Part 2, which is the subject of the present review, describes three of these provinces the Dharwar-Mysore-Nellore Province, the Chanda-Bastar Province and the Singhbhum-Orissa Province.

THE DHARWAR-MYSORE-NELLORE PROVINCE.

This is the first province to be described as it contains the so-called "classic ground in which Foote originally separated the Dharwar formation from the associated gneisses." In other words its priority arises entirely from historical considerations. Sir Lewis treats us to a fine summary of the work which has been written on the non-charnockite areas of South India, and lucidly traces the oscillations in view-point and understanding of successive geologists who have worked on these rocks.

Newbold's earliest views, expressed in 1844, that the granitic rocks had intruded into earlier schists and gneisses, was largely accurate and it is curious that over 60 years elapsed before this view became accepted. It is a fine illustration of how scientific advancement is so often held up by blind belief in a popular view.

R. B. Foote's first descriptive work on the South Indian rocks appeared in 1876, but it was not until 1886 that he proposed the term "Dharwar" for the schistose rocks which occur as wide bands in the "granitoid gneisses," and later described eight such bands. He refers to the Dharwar system as "Lower Transition," and, rejecting Newbold's views of the intrusive relation of the gneisses into the schists, concluded that the Dharwar rocks rested unconformably on the granite-gneisses.

J. Malcolm Maclaren, who worked in this part of India for a very short time at the beginning of this century, continued to believe in this stratigraphic unconformity between the Dharwars and granite-gneiss. Maclaren did no detailed mapping yet he drew comparisons between these Dharwars and the rocks in Chota Nagpur, Rajputana and even Bihar and Shillong. Maclaren's work in the economic field was invaluable, and he was one of my earliest friends in geology, but I am of the opinion that this correlation was the one unfortunate contribution which Maclaren made to Indian geology. The term Dharwar should not have been given such a wide significance in Indian geology at that stage, as the comparisons were not based on mapping but on mere generalised lithological resemblances. Its use has given a bias or colour to all subsequent work in these areas, which should never have been present.

Then followed the work of the Mysore Geological Department of which Foote himself was the founder. No comprehensive account of this part of India has appeared since Smeeth's outline in 1916. The Dharwars are divided into an upper (chloritic) and a lower (hornblendic) division without any break between the two, and the whole intruded by a succession of granites and basic igneous rocks, the Dharwars being recognised as the oldest rocks present. Smeeth, in 1926, concluded that the "lower division" is intrusive into the "upper," a view which Jayaram later rejected. A calcareous and manganiferous division has also been recently recognised, and known as the "Sakarsanhalli series" which may be a still lower division. Of the intrusive granites the Peninsular gneiss is the most widespread.

The various opinions as to whether the quartzites, ferruginous quartzites, limestones and schists are of sedimentary origin or are due to replacement of igneous rocks, are stated fairly enough by Sir Lewis, as also is the controversy concerning the sedimentary or crush origin of certain conglomerates. Notwithstanding that Sir Lewis refuses "to accept any conglomerate in the Archæan as truly sedimentary except on the most rigid proof," an attitude which he so strongly assumes in Part I, it is good to read that he does acknowledge the recent views of Rama Rao and Pichamuthu that sedimentary conglomerates actually occur. His criticism of Iyengar's, Smeeth's and Jayaram's inclusion of the intrusive Champion gneiss as part of the Dharwar system is justifiable.

Rama Rao and Jayaram were the first of recent writers to reject the view of Smeeth and Iyengar that all the Dharwars are of igneous origin, and they accept a sedimentary origin for many of these rocks,

*"An attempt at the correlation of the ancient schistose formation of Peninsular India," by L. L. Fermor, *Memoirs of the Geological Survey of India*, 1936, **70**, Part 2, No. 1, pp. 53–217.

Sir Lewis' review of this work in South India leaves an impression that needless, weak and illogical arguments were the burden of past descriptions, and that a little acknowledgment of simple views and analogies from other areas would have cleared the air. It is all expressed so concisely by one small phrase in the memoir: "After all, the Sakarsanhalli rocks are mainly shreds"—the same might be said of all these schist belts of South India as compared with the Archæan tracts in other parts of the country. This, indeed, is one of the reasons why I believe that the Dharwars have been given a position as a type system in our Indian stratigraphy out of all proportion to their importance. Those who have worked long in India will read this historical account with a certain feeling of regret, perhaps, that Sir Lewis has found it necessary to take out some of our skeletons once more for an airing.

CHANDA-BASTAR PROVINCE.

This extends north from the Godavari River and three-quarters lies in the Central Provinces. It is bounded on the east roughly by the Eastern Ghats and on the west by the Deccan Traps, Gondwanas and Puranas. Little has been published concerning this tract during recent years, and the last memoir of any importance appeared in 1902. Sir Lewis refers to Smith's account of the Raipur and Sambalpur Districts, dated 1899, as "fairly modern"! Amongst other faultings Sir Lewis deduces evidence for a fault zone some 600 miles in length, which threw down the Chandar-Bastar Province several thousand feet relative to the adjacent Eastern Ghats Province.

During the last few years Geological Survey of India parties have been engaged in the Bhandara District of this province under the supervision, until recently, of Sir Lewis. Here, the Sakoli series is regarded as younger than the Sausar series which crops out to the north. A survey of Bastar State in the eastern part of this province, has recently been commenced by Mr. H. Crookshank and Dr. P. K. Ghosh. There, a series of metamorphosed sediments have been intruded by granitic rocks; ferruginous quartzites form an important part of the series. Summarising the features of the Chanda-Bastar Province Sir Lewis notes that the phyllites, schistose rocks and gneisses are more or less parallel to the general north-south trend of the rocks in the Dharwar-Mysore-Nellore Province. The phyllite-schist suite has received different names in different areas: Sakoli series in Bhandara, Chilpi Ghat series in Balaghat and Drug, and Sonakhan series in Bilaspur, Raipur and Sambalpur. All are compared with the Dharwars of South India. The chief rocks are slates, phyllites, mica schists, chloritic and hornblendic schists, quartzites and hematite-quartz-schists. Calcareous rocks are entirely absent.

The province is very large, the schists are widely separated in the granite-gneiss. So little is known, apart from the Sakoli and Sausar series, that there is no justification for any correlation as yet between each area.

THE SINGHBHUM-ORISSA PROVINCE.

We come next to the area which has been my own hunting ground during the last fifteen years. It is a small province, but it will be interesting to see later the reason for the separation of the Ranchi and Bihar Provinces which lie to the north, and which in actual fact form a very definite unit with Singhbhum geology. Economically it is the most important of all the provinces.

Sir Lewis summarises the early work of Haughton, Stoehr, Ball, Maclaren and Fermor in Singhbhum and surrounding areas; of these Ball alone did any extensive mapping, but Fermor mapped about 20 square miles around some chromite deposits. The early views were more or less parallel to those expressed for South India, except that at no time was such a wholesale relation of schists to an igneous origin postulated. Ball's memoir (1881), the result of reconnaissance work of a most erudite type, was the most momentous, but to a modern reader it suffers from inhibitions attendant on the geological beliefs of those days—the same will certainly be said of our own work, perhaps, in the future!

An important omission is the work of K. A. K. Hallowes in 1905–08, whose progress reports were available to Sir Lewis. He was the first to point out the intrusive nature of the granites into the schists, and there is much valuable information buried in Hallowes' reports.

A good account is given of the more modern detailed surveys which have covered approximately 10,000 square miles since 1920. The three principal workers, Jones, Dunn and Krishnan, receive a good hearing, with also a mention of Dey's work; I should have liked to have seen some reference to the work of other colleagues, for example to Hobson and Iyer who have done some useful mapping in this area. This work has been recently described in several memoirs and others

will appear shortly. But even so, I feel that our conclusions are unsatisfactory. Almost at the beginning Jones found that wonderful section along the Deo river where the basal bed of the Iron-ore series rests on the vertical beds of an older metamorphic system—in no country have I seen exposed so clear a section of the unconformity between two Archæan systems. Almost from the beginning, therefore, we were aware that two systems of rocks were present: indeed my own field-work in India commenced from the actual site of this Deo river section. In Singhbhum and surrounding areas we have the following succession:—

Iron-ore series:
- (7) Dalma lavas, with agglomerates and phyllites.
- (6) Dhanjori quartzites (with occasional conglomerates) impersistent.
- (5) Phyllites with tuffs, lavas, limestones, conglomerates, quartzites.
- (4) Banded-hematite-quartzite.
- (3) Shales, phyllites, mica-schists.
- (2) Limestones—impersistent.
- (1) Basal sandstone–conglomerate.

Older Metamorphic System.

The Older Metamorphic system does not cover a wide area, but wherever found its rocks are in every respect lithologically similar to the metamorphosed types of the younger Iron-ore series. Although no banded hematite-quartzites and iron-ores have as yet been found in the older group, the fact that pebbles of these ferruginous rocks occur in the basal conglomerate of the Iron-ore series indicates that such iron-ore rocks were present in the Older Metamorphic system. Lithologically the older system resembles the Dharwars of South India just as much as does the Iron-ore series.

The Iron-ore series should be regarded as a *system*, but it is the policy of the Geological Survey to retain the term *series* until correlations between widely separated areas have been effected. The unconformity between the Older Metamorphic system and the Iron-ore series represents a vast period of time, but in the Iron-ore series itself there are overlaps and erosion intervals permitting a grouping of the beds into stages. Going downwards in the system there was an erosion interval immediately preceding the Dalma lavas, a very considerable erosion interval preceded the Dhanjori quartzite and conglomerate, brief intervals occurred in the underlying stage of tuffs, etc., and finally, in South Singhbhum and Keonjhar, such a prolonged period of erosion preceded the banded hematite-quartzite that almost the whole of the underlying shales were removed and the Iron-ore beds occupy almost a basal position.

Sir Lewis discusses the outcrop of basal conglomerate immediately around the Deo river section as if it were a problem. There is no problem to those of us who have followed this bed along the strike—I personally have mapped it for over 30 miles where it is found continuously between the granite and overlying shales and limestones. There is, however, a problem in regard to the adjacent Singhbhum granite. Most of this granite is definitely intrusive into the Iron-ore series, but I am of the opinion that some of the granite intrusive into the Older Metamorphic system is older than the Iron-ore series. Most of Sir Lewis' difficulties arise from the fact that his acquaintance with the geology of this area is based largely on a traverse of the copper belt and on a few brief visits.

Continuing these surveys to the west, in Gangpur State, Dr. Krishnan has recently found a suite of calcareous rocks which he calls the Gangpur series, and which he believes is older than the Iron-ore series, but younger than the Older Metamorphic system. Recognising the several erosion intervals within the Iron-ore series, some of which have been very prolonged, and having surveyed the country up to the border of Krishnan's area, it seems to me possible that the Gangpur series may represent a stage (not necessarily basal) of the Iron-ore series (or system) elsewhere removed. However, discussion of this may be preferably left until Krishnan's memoir appears and his evidence can be more fully appreciated. Sir Lewis Fermor would correlate the Gangpur series with the Sausar series of the Central Provinces—still, 350 miles separate the two areas and correlation at this stage seems to be mere speculation.

Fermor remarks that in 1929 I discussed the possibility of correlating the Singhbhum rocks with the Dharwars of South India, following my predecessors. I no longer do so, however, for I regard such correlation as premature. Sir Lewis commences by accepting them as Dharwars, then sets out to prove his correlation.

At the end of each chapter the features of the province described are summarised and the lithological resemblances indicated on which a correlation with other areas may be suggested. These lithological grounds

reach a maximum for the Singhbhum-Orissa Province. They include such rocks as iron-ore deposits, hornblende-schists, aluminous rocks, manganiferous rocks, calcareous rocks, carbon phyllites, ultrabasic rocks, and granophyres. Of the iron-ore deposits similar rocks must have occurred in the Older Metamorphic system, as also do hornblende and other schists, and ultrabasic rocks. Of the manganiferous rocks we have at least two horizons in the Iron-ore series, either of which could have given rise to gonditic types under suitable metamorphism, and there are also the manganese deposits in the Gangpur series. Calcareous rocks are present in the Iron-ore series, sometimes thick but impersistent in this area—it is easy to visualise their swelling to the proportions known in the Gangpur series. Carbon phyllites are present in both Iron-ore and Gangpur series; it is not correct to say they are less important in the Iron-ore series, as Sir Lewis believes. As to the intrusive granophyres, from pebbles in the Iron-ore series there was a pre-Iron-ore granophyre, another is intrusive into the Iron-ore series and yet a third is an acid differentiate of the much later Newer Dolerites—microscopically identical with each other. These rocks provide no reliable evidence and I, personally, cannot accept any correlation on lithological grounds. To geologists not familiar with our Indian Archæan geology there is the possibility that resemblances marshalled in this way may appear to masquerade under the guise of logical premises. Time after time colleagues working with me in my area or in other areas have discussed with me these lithological similarities to the Iron-ore series rocks, but in recent years I have believed it wiser to put a brake on this type of correlation, and await the accumulation of evidence which will form a more logical basis. The field of comparative stratigraphic succession should prove a valuable aid, however, and there are signs of its ultimate use in Fermor's account.

It appears that Fermor's correlation, so far as his account has gone, is approaching lines similar to those which have suggested themselves to his colleagues, but which they have hesitated as yet to pursue.

In this review I have found it a little difficult to sift the principal features from the mass of detail irrelevant to the object of the memoir. Furthermore Sir Lewis has not always accurately recorded my less important views and I rather suspect the same on other minor points. I should like to have seen extracts taken from individual worker's own memoirs wherever possible rather than from General Reports; this particularly applies to the memoir of H. C. Jones which was in Sir Lewis' hands some three or four years ago.

J. A. DUNN.

ASTRONOMICAL NOTES.

Comet 1936 C.—The Third Comet of the year was discovered on the night of September 20, 1936, by Mr. Jackson at Johannesburg, and a day later, independently by Prof. Neujmin at Simeis, Crimea. The comet was of the the 12th magnitude at that time and near its maximum brightness, but seems to have faded rapidly declining to about the 14th magnitude on October 12. Mr. Jackson has computed a preliminary orbit from three observations and finds the time of perihelion passage to be 1936 October 2.

Another New Star in Aquila.—Another Nova in the Constallation Aquila (Nova 668, 1936) was found by Prof. Tamm from examination of photographic plates taken at the Stockholm Observatory. The magnitude on October 7 was 7·6 and the position is given by

R.A. $19^h\ 23^m{\cdot}5$; Decl. 7° 29′ N. (1936·0).

The star is getting gradually faint, its magnitude on December 2 was estimated to be 9·4.

Two New Stars.—A nova was discovered on September 18, in the Constellation Aquila by Tamm, a Swedish astronomer, when its magnitude was 8·0. Its position (for 1936·0) is given by R. A. $19^h\ 14^m{\cdot}0$.; Decl. 1° 36′ N. The star was already decreasing in brightness, its magnitude on September 23 having declined to 8·8. There seems to have been a secondary maximum since then, and the brightness on November 3 was observed to be again $8^m{\cdot}0$. Information has been received of the discovery of a nova on October 6 by Mr. C. Jackson of the Union Observatory, Johannesburgh, South Africa. The star is situated in the Constellation Sagittarius and was about the sixth magnitude at the time of discovery.

T. P. B.

CENTENARIES.

S. R. Ranganathan, M.A., L.T., F.L.A.
(*University of Madras.*)

Jonh Maurice Brühl (Count), 1736-1809.

J. M. BRÜHL, the German diplomat, who made a name as an amateur astronomer, was born at Wiederan in Saxony on 20th December 1736. He was a nephew of Count von Henry Brühl, the Saxon minister, whose establishment of 200 servants was larger than the King's and about whom Frederic II said "Of all men of his age, he had most watches, dresses, lace, boots, shoes and slippers." This amazing collection of watches seems to have had a profound effect on his nephew. For, it s claimed that the most signal benefit conferred by J. M. Brühl on Science was his zealous advancement of chronometry.

HIS CAREER.

Having received his education at Leipzig, Brühl entered diplomatic service at the age of nineteen. Having seen service at Paris, Warsaw and Thuringia, he took up the post of envoy extraordinary in England in 1764 and stayed there till his death.

HIS SERVICE TO ASTRONOMY.

Brühl loved astronomy with passion. In association with astronomer von Zash, he determined the latitudes and longitudes of several places, with a Hadley's sextant and a chronometer of Emery. The results were embodied in a book published in 1786. It gave the latitudes and longitudes of Brussels, Frankfort, Dresden and Paris. Another publication of his came out in 1794 under the title *On the investigation of astronomical circles*. He also contributed frequently to *Astronomisches jahrbuch*.

HIS SERVICE TO CHRONOMETRY.

As has been already stated, the impression produced in his youthful mind by the unusual collection of watches in his uncle's palace, made him devote much thought to chronometry in his later age. He published his *Three registers of a pocket chronometer* in 1785, his *Nouvean journal du chromitra* in 1786 and *A register of Mr. Mudge's time-keepers* in 1790. He was the acknowledged patron of Thomas Mudge, the famous British horologist, who is known to have made the first watch of Dr. Johnson in 1768 and to have invented the lever escapement. In his *A description of the timekeeper* (1799), Mudge explicitly acknowledged that the realisation of his improvements in watch-making was largely due to the help of Brühl.

Brühl died at his house in Old Burlington Street, London on 9th June 1809.

John Johnstone, 1768-1836.

JOHN JOHNSTONE, a physician and a medical author, was born in Kidderminster in 1768. He belonged to a family rich in tradition. His father James was a famous medical doctor, who wrote a treatise on *The Malignant epidemic fever*. Two of his brothers also were famous in medicine. The eldest, James, distinguished himself by his thesis *De angina maligna*. The second, Edward, received well deserved praise from the profession for his thesis, *De febre puerperali*, and got elected as the first physician of the Birmingham General Hospital. His nephew, James, became the first Professor of Materia Medica at Queen's College.

HIS CAREER.

John Johnstone became an M.B. of Edinburgh in 1793 and practised medicine in Worcester till 1799, when he removed to Birmingham, where he gained a large practice. He became M.D. in 1800, and a Fellow of the Royal College of Physicians in 1805. He was elected Harveian Orator in 1819. He was President of the second meeting of the Provincial Medical and Surgical Association by which name the British Medical Association first came into existence.

Johnstone's medical skill and general learning were considerable and his character was highly valued. He published six treatises on different topics in medicine. He died at Birmingham on 28th December 1836, aged 68.

Charles Frederic Chandler.

C. F. CHANDLER, the American chemist, was born at Lancaster, Mass., on 6th December 1836. His father was a merchant at New Bedford. While he was studying in the local school, he happened to listen to some occasional lectures on chemistry by Louis Agassiz. They roused his scientific curiosity and at fourteen he resolved to become a chemist and stuck to it. Even then he began to collect minerals and rig up a little chemical laboratory. In his

ardour for science, he neglected the classics and this stood in the way of his admission to the University. After spending some time in the Lawrence Scientific School at Harward, he crossed the Atlantic as supercargo on a sailing ship carrying whale oil to Antwerp. He spent three years at Berlin and Gottingen under Wöhler and Rose and got his doctorate in 1856.

HIS CAREER.

On return home, he sent a paper to the *Scientific American* on the preparation and use for lamps of mineral oil, but it was turned down on the ground that the use of mineral oil in lamps was too fantastic a notion for publication! Hearing that an assistant was required at the Union College, he went all the way to that place. But the trustees had sanctioned only a janitor's post. "I'll take the job of janitor" said the Doctor of Gottingen and without hesitation, he proceeded to sweep out and do general menial's work before and after hours for which he was paid and to assist the professor and to instruct in official hours for which he was not paid. It happened that the professor of chemistry left the college in a year and Chandler, the janitor, was made the professor. This was in 1857. He occupied the Chair of Chemistry of the Columbia University from 1864 to 1911. It is said that his students were like sons to him. He was jealous for their welfare. Much of his income went to help them. If his liberality was abused, he straightaway forgot all about it. As a mark of gratefulness, his old students established in his honour the Chandler Lectureship and the Chandler Medal for research in chemistry.

HIS CONTRIBUTIONS TO SCIENCE.

Chandler's early contribution to the study of illuminating oils has been already referred to. Later in life, when kerosene lamps became popular, fatal explosions were found to be frequent. He worked hard to avert such explosions and established proper standards of illuminating oils and a scheme of flash point tests. His work in this matter was so efficient that he was invited as an expert adviser by the British Government. When the New York College of Pharmacy was a struggling little school, he did considerable honorary teaching and developed it till it was taken over by the University. He became a leading authority on water-supply and sanitation. As early as 1866, he took up, as an honorary job, the regulation of the food supply and the sanitation of New York. He soon became a pioneer in municipal milk control. Another invention of his, which has now come into universal use, is the flush closet. He refused to patent this idea and allowed it to be exploited by anybody, so that more healthful homes might come into existence. In all his contributions, he never equated them with money or with any kind of personal advantage. He is indeed said to have been "One of the most effective crusaders of his time in behalf of the public good."

In the field of applied chemistry, he made leading contributions to the sulphuric acid industry and in 1866 he discovered the ingeneous system of ton-weight assaying, which is now in general use.

HIS HONOURS.

Chandler was a prominent member of the American Chemical Society, and of the National Academy of Sciences. He was an active member of several other American Societies, and of the Chemical Societies of several foreign countries. The collection he had made through his long life became the nucleus of the Chandler Chemical Museum of Columbia. He was greatly respected in scientific circles. His presence was always felt to be a joy and inspiration to others. The most difficult tasks became easy in his presence. He is described as a catalyst to encouragement, for he is said to have had a remarkable faculty in making men believe in themselves.

He died in his eighty-ninth year, on August 25, 1925.

RESEARCH NOTES.

Arithmetical Investigation of Elliptic Integrals.—Schneider (*Math. Ann.*, *Band* **113**, Heft 1, pp. 1–13) has proved three general theorems from which a variety of interesting results concerning the transcendency of elliptic integrals can be deduced. These are the following: I.—The six numbers a, b, g_2, g_3, $\wp(\beta)$, $a\beta + b\zeta(\beta)$. $\{\wp(\beta), = \infty, |a| + |b| \neq 0\}$ cannot all be algebraic. II.—If $\wp(x)$ and $\wp^*(q^x)$ be algebraically independent and $x = \beta$ not being a pole for either, then at least one of the seven numbers g_2, g_3, g_2^*, g_3^*, $\wp(\beta)$, $\wp^*(q\beta)$, q, is transcendent. (These theorems are slightly sharpened by him by utilising the transformation $\beta' = \lambda\beta$.) III.—If $\wp(\beta) \neq \infty$ and g_2 and g_3 are algebraic, then at least one of the three numbers $\wp(\beta)$, $q \neq 0$, and $e^{q\beta}$, is transcendent. The proof consists in constructing a polynomial

$$L(x) = \sum_{\lambda=0}^{n-1} \sum_{\mu=0}^{n-1} C_{\lambda\mu} \wp^{\lambda}(x).[ax + b\,\xi(x)]^{\mu}$$

which r-ply vanishes at the points $\alpha_k = k.\beta$ ($k = 1, 2, \ldots t$, under the supposition that if $\wp(k\beta) = 0$, the corresponding α_k is omitted), where $t = 24s + 1$, and s is the degree of the algebraic field to which the numbers belong (assuming that all the sets of numbers in the theorems to be algebraic) in such a way that the coefficients c are all algebraic integral and all their conjugates are

$$< K_3^{r} \cdot r^{2r}, \quad \text{where } r = \left[\frac{n^2}{2t}\right]$$

This is constructed by making use of the formulæ and some inequalities of elliptic functions. Then he proves that if $L(x)$ possesses these properties, then it should be identically equal to zero by which the theorem is obtained.

The results obtained are extremely general and a few particular results are stated below: (1) The length of an arc of an ellipse whose axes-lengths are algebraic between algebraic values of the ordinates cannot be algebraic. (2) In case g_2 and g_3 are algebraic ω, η, ω/η, ω/π, are all transcendental. (3) If $J(\tau)$ is algebraic, then τ is either imaginary-quadratic or transcendental. (4) α and $\wp(\pi\alpha)$ cannot both be algebraic.

K. V. I.

Series-Developement in Invariant Theory Particularly in the Quarternary Field.—B. L. Vander Waerden (*Math. Ann.*, **113** Band, I Heft, 14–35) has obtained important generalisations of some fundamental results in the theory of invariants and has proved some unproved results of Gordan. In this article he builds up the theory of invariants and covariants of any system of *group-numbers* (*i.e.*, *Gruppen-Grose*) with respect to any group of transformations. As he presupposes a bare acquaintance of the theory of representations of groups, the article can be read with profit by those wishing to learn the modern conceptions of invariant theory and the beautiful and simple modern proofs of the results. (A synopsis of the foundations is given in Weyl—Group-theory and quantum-mechanics, Ch. III).

At the outset he defines a group-number as any quantity which is transformed linearly by the operators of a group G, *viz.*, vectors, tensors, spinors (in connection with the orthogonal group), linear forms in any number of variables, etc. We obtain therefore a representation of the group with respect to a group-number. A covariant of a group-number f (or a system of numbers) is another group-number whose elements are homogeneous polynomials of those of f which is transformed in the same way as f. The fundamental problem of covariant theory consists in finding a process of building up of all the covariants of a given system. This problem is resolved finally to the problem of expressing the product of two irreducible representations of a given group in terms of the irreducible representations of the group. The true significance of the Clebsch-Gordan series of the classical theory of invariants is that it gives us the product of two irreducible representations in terms of the irreducible representations of the linear group. An invariant is obviously a covariant corresponding to a space of order one. First of all the (linearly independent) linear invariants of a homogeneous form

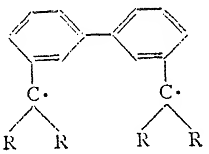
$$f = \Sigma\, a_{r_1 r_2 r_3 \ldots r_k}\, x_1^{r_1}\, x_2^{r_2} \cdots x_k^{r_k}$$

are found out as follows. The group induces a representation with respect to the form f. Now if this representation is resolved into irreducible representations, the number of linearly independent invariants is easily seen to be, equal to the number of irreducible representations of order one occurring in the representation f. The number of linearly independent linear covariants of f is easily seen to be equal to the number of irreducible contra-gredient representations of order k (assuming k to be the number of variables in f) occurring in the representation f. Invariants and covariants of higher orders involving higher powers of the coefficients of f are obtained by resolving the powers (formed in the Kronecker-way) of the representation f. (The process is called the polar process.) It is easily seen that the process gives not only the number but the invariants and covariants themselves.

In the latter part of the article he considers the special linear group and particularly the quarternary forms. Making use of the connection between the irreducible representation of this group and the corresponding permutation group (*i.e.*, the Frobenious-Young theory) he deduces many important results in particular generalisations of some of Study's results in the ternary case and some results given without proof by Gordan.

K. V. I.

Valence-Tautomerism in Unsaturated Compounds.—It is known that the presence of uncompensated single electrons in organic compounds such as in the mono radicals triphenyl-methyl or tribiphenyl-methyl, makes them paramagnetic. The same paramagnetism has



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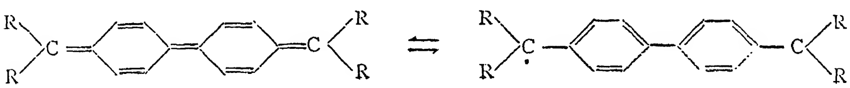
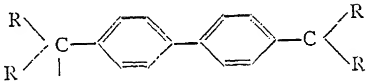
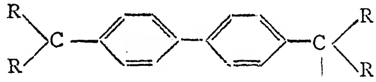


II III



$\longleftrightarrow$ III $\longleftrightarrow$



IV V

also been observed in a typical bi-radical, *viz.*, *m*, *m′*-Diphenylene-bis-(diphenyl methyl) I. One should expect on similar grounds that the mesomeric form III of tetra phenyl-dimethylene-diphenoquinone II, which is the *p*-analogue of the *m*- bi-radical and shows chemically a bi-radical nature, must also be paramagnetic.

The observed diamagnetism of this compound is therefore very striking and indeed E. Müller has pointed out that in all bi-radical compounds which can be mesomeric with a quinonoid structure, only diamagnetism is to be found. In the observed bi-radical form therefore it must be postulated that the spin of the two lone electrons in the two separate atoms must be compensated, and this would mean a new kind of chemical binding. B. Eistert (*Ber.*, 1936, 69, 2393) has discussed this difficulty and explains that these two electrons responsible for colour and unsaturation, are not separate but paired as indicated by the observed magnetic property and that the paired free bond is alternately on either of the two methyl C-atoms, the structures III, IV and V being in quantum-resonance.

A number of other similar cases are also discussedi n this interesting paper.

M. A. G.

Contact Potentials of Reversible Soluble Films of Lauric Acid.—The accumulation of surface-active solute molecules on a freshly swept surface of solutions of benzopurpurin and nonylic acid has been studied by Doss (*Curr. Sci.*, 1935, **4**, 405; *Proc. Ind. Acad. Sci.*, 1936, **4**, 97). A similar observation has been made by Harkins and co-workers (*Nature*, 1936, 138, 405), with saturated solutions of lauric acid by measurement of the variation of surface pressure and contact potential with time. Upon sweeping the surface rapidly the surface-active molecules slowly accumulate by diffusion from below with a rise in the surface pressure by about 6 dynes per cm. and fall in contact potential by 120 m.v.

Upon compression the surface pressure may increase to about 25 dynes per cm. and the contact potential may drop to – 200 m.v. which return to the equilibrium values, in about half an hour owing to the diffusion of molecules of the compressed film into the interior.

The observations indicate the importance of time factor in the determination of surface tension of solutions of surface-active substances and the imperfectness of the dynamic methods for determination of surface potentials.

K. S. RAO.

The Role of Certain of the So-called Non-Essential Elements in Plant-Growth.—The response of wheat grown in water cultures to the elements cobalt, iodine, zinc, aluminium, manganese, lithium and sodium supplied in the form of their chlorides is the subject of a study by B. N. Singh and S. Prasad (*Ind. Jour. of Agric. Sci.*, **6**, Part III). The culture solutions contained these compounds in four different concentrations, *viz.*, ·01M, ·005M, ·0005M and ·0001M. In addition to the growth characters recorded estimations were also made of the dry matter, the different carbohydrates, and the nitrogen content. The first two strengths have proved toxic while the second two have had a stimulating effect in all cases except NaCl in which the effect has been quite the contrary, *viz.*, the highest strength was stimulative, the second less so, the third not stimulative at all and the last slightly retarded the growth. $ZnCl_2$ was remarkable in the stimulative effect, growth being very vigorous and the dry matter yield also higher than in the controls. The chlorides of cobalt and iodine were found to be the most toxic, even the lowest strength was not free from toxicity. As regards the accumulation of carbohydrates, the effect is very varied; the sucrose content is in almost all cases below the controls; the starch content, in the majority of cases is higher than in the controls; the glucose was either just equal to or less than the controls except in the case of NaCl where it was greater; the total carbohydrates in the case of Na, Li, Zn and Mn, were higher at the stimulative strengths. The nitrogen in practically all the cases was lower except in the case of $ZnCl_2$ at the higher strengths which however are toxic strengths. On the whole it is difficult from these experiments to stress the importance of any of these elements, as the stimulative and beneficial effect in one direction appears to be counteracted by the baneful effect in other directions.

Quality of Lint in Relation to Ginning Factors.—The effect of changes in the setting of the moving knife in a roller gin and of different speeds in a saw gin on the quality of the resulting lint has been studied by Nazir Ahmad and R. P. Richardson (*Tech. Bull. Series A.*, No. 31, of the Indian Central Cotton Committee Technological Laboratory). The studies relate to two adjustments in the roller gin, *viz.*, an overlap of $\frac{3}{8}''$ and $\frac{4}{8}''$ for some and $\frac{4}{8}''$ and $\frac{5}{8}''$ for some others of the nine samples of cotton studied, while the saw gin speeds were 325 and 425 r.p.m. for all the samples. The latter comprised types of long,

medium and short staple cottons ranging from 0·70 to 0·94 inches of mean fibre length. It is concluded from the results that in respect of the important quality factors staple length and strength of yarn, and in cleanliness, the smaller overlap in the roller gin and the lower speed in the saw gin were more beneficial than the larger overlap and the higher speed. Better out-turns however resulted from the larger overlap and the higher speed, so that it looks as though the interests of the ginner, and the millowner looking for better quality, cannot both be served at the same time by any particular setting of the gin. The larger overlap also gave the higher ginning percentage with the majority of the varieties, but in the saw gin neither of the speeds made any appreciable difference; likewise no difference was made in the yarn neppiness by any of the adjustments of either the roller or the saw gin. The complexity of the factors involved in a study of this kind due both to ginning methods as well as to the character and condition of the seed cotton is referred to and the present study is stated to be the first of a series. We would at this stage ask the authors to consider if it will not be possible without sacrificing accuracy to carry out these tests with actual Factory units and thereby make the results applicable directly to ginning factory practice.

A. K. Y.

Cytological and Morphological Researches in Some Indo-Malayan Loranthaceae.—A paper of great interest, concerning one of the three recent works on Loranthaceæ, based on material collected by Prof. A. Ernst and his wife, Dr. M. Ernst-Schwarzenbach, during their botanical excursion to the Indo-Malayan region in 1930–31, has recently been published (Rauch, Konrad von, "Cytologisch-embryologische Untersuchungen an *Scurrula atropurpurea* Dans. und *Dendrophthœ pentandra* Miq.," *Ber. Schweiz. Bot. Ges.*, 45, 5–61).

The development of the male gametophyte proceeds in a normal way. The tapetal cells are mostly uninucleate and the mature pollen grains are 2-nucleate. In both species the diploid number of chromosomes is 16 and haploid 8.

The development of the gynæcium shows some extraordinary phenomena. As in other Loranthaceæ, investigated by older authors, ovules in the usual sense are absent. There are no integuments and even the nucellus is not marked out from the surrounding tissue of the inferior ovary. There is a many-celled archesporium; the number of megagametophytes varies from 3 to 5 in *Sc. atropurpurea*, but goes up to 12 in *D. pentandra*. The embryo-sacs elongate considerably both upward and downward. Their progress on the lower side is soon checked by a layer of collenchymatous cells, but the upper end continues to grow aggressively and penetrates far up into the stylar canal—in *D. pentandra*, where the style has an average length of 15.5 mm., one embryo-sac was only 4.5 mm. below the stigma! Protrusions of nucelli and embryo-sacs into or through the micropyle have, it is true, been recorded before in other angiosperms, but such an extreme case is not known outside its family. Indeed, the downcoming pollen tubes and the up-growing 'embryo-sac-tubes' offer, in the opinion of the reviewer, a parallel to the condition in *Welwitschia*, although the two plants are too differently related to permit much speculation. Double fertilisation occurs in the usual way, but this event takes place in the style and not in the ovary! The endosperm seems to be cellular from the very beginning. The first division of the egg is longitudinal, followed by some transverse divisions, resulting in a 2-rowed suspensor and a bi-celled embryonal primordium at the tip. In the mature fruit only a single embryo is present, since the others degenerate at one time or the other during the course of their development. By a fusion of neighbouring embryo-sacs the different endosperms become united to form a common nutritive mass for the surviving embryo.

Dr. Rauch's work is of more than usual interest and readers would consequently have welcomed a more detailed account of the earlier development of the embryo-sac. The statement—"es werden drei Makrosporen gebildet, von denen die oberste zum Embryosack auswächst"—is ambiguous. Strictly speaking, a row of "three megaspores" does not occur at all, for one of the three must be a *dyad cell* that has failed to undergo the second reduction division. Whether the uppermost cell, in this case, is a dyad or a real megaspore, is not made clear by the author, and so it is impossible to say if the development is of the "*scilla*-type" (it would be more correct to call it the "*Allium*-type," since it was first discovered in *Allium fistulosum*) or Normal-type.

A study of the embryology of some Indian Loranthaceæ is now being carried on at Cuttack in Prof. P. Parija's laboratory and the results thereof will be awaited with keen interest.

P. MAHESHWARI.

AN attempt to use the **structure of the generative cell as an aid in the solution of systematic problems** (Wunderlich, *Öster. Bot. Zeit.*, 1936, 85, 30–55) has been made by Miss Wunderlich. She herself calls it only an attempt, since the aceto-carmine method, which she employed, does not give good results in every case.

It has been found that, as a general rule, species of the same sub-tribe show a similar structure of the generative cell and nucleus. Since it is quite impossible to mention all the details, the reviewer is citing just one instance here. In the tribe Asphodeloideæ, members of the two sub-tribes Asphodelinæ and Anthericinæ were investigated. In *Asphodeline lutea*, *A. liburnica* and *Eremurus spectabilis* (Asphodelinæ) the generative plasm could not be made visible but the long thin generative nucleus stained well. In *Paradisia liliastrum*, however, which is included by Krause in the same sub-tribe, a spindle-shaped generative cell was clearly visible and the generative nucleus was found to be broader and shorter than in the other two genera of this sub-tribe. A similar structure of the generative cell was seen in the sub-tribe Anthericinæ in 3 species of *Anthericum*, in *Chlorophytum Sternbergianum* and *Echeandia terniflora*. On the other hand, *Bulbine caulescens* (placed by Krause in the Anthericinæ) showed a structure comparable to that in *Asphodeline* and *Eremurus* (Asphodelinæ). Miss Wunderlich concludes from this that the genus *Paradisia* ought to be transferred to the sub-tribe Anthericinæ and *Bulbine*,

on the other hand, to the Asphodelinæ. This is in accord with the conclusions reached by Stenar (1928) and Schnarf (1929, 1931) on embryological grounds.

It may be noted that in some cases (*Haworthia, Fritillaria, Tulipa* and *Ornithogalum*) the generative plasm could be seen even in the unstained pollen grains mounted in water. The reviewer can add to these *Hippeastrum hybridum* (Amaryllidaceæ) from his own experience.

It is to be commended that the author is very cautious in her conclusions. In those cases where the generative plasm was not stained with aceto-carmine, she does not conclude (like some other authors!) that *it did not exist at all*, but that *it could not be made visible*. The same care is exercised in statements with regard to the existence of the vegetative nucleus. In species of *Allium* it stained as deeply as the generative nucleus itself, in some other cases it stained very lightly, while in still others where it could not be stained at all, Miss Wunderlich avoids the usual (and hasty!) conclusion that it had degenerated.

H. D. WULFF.

Fossil Algae from the Trichinopoly Cretaceous S. India. About 5 years back, in August 1931, Prof. L. Rama Rao reported through the columns of *Nature* the discovery of numerous algæ in the uppermost Cretaceous beds (the Niniyur group) of the Trichinopoly District, S. India. These have now been studied by Dr. Julius Pia of the Natural History Museum, Vienna, who is a well-known authority on fossil algæ and the results published in a recent *Memoir of the Geological Survey of India* (*Pal. Ind. N. S.*, **21**, 4) under the joint authorship of Prof. L. Rama Rao and Dr. Julius Pia. In part I of this memoir, Prof. Rao has given a detailed account of the geology of the Niniyur group, with special reference to the algæ-bearing rocks. The flints and cherts associated with this group have been proved to be the result of silicification of limestones, which they resemble both in general appearance and the character of the included fossils. Regarding the mode of origin of the Niniyur rocks, it has been shown that they were deposited during a local and independent post-Senonian transgression of the sea in the north-eastern part of the Trichinopoly Cretaceous area, and are of Mastrichtian-Danian age. In part II, Prof. Pia describes the fossil algæ present in these rocks—chiefly belonging to the four families: Solenoporaceæ, Corallinaceæ, Dasycladaceæ, and Chætophoraceæ. Of these the most important from a botanical and stratigraphical point of view are the Dasycladaceæ, of which several new genera and species have been described. Of the Corallinaceæ the most common form is Archæolithothamnium. The general character of the Niniyur algal flora suggests an age transitional between the Cretaceous and Eocene systems. While these algæ cannot be employed to decide stratigraphic questions in this area, the sequence of strata in this region will be a typical section, and the algæ could be used to correlate strata in other parts of the earth with those in the Trichinopoly District and thus to fix the geologic age of these foreign sediments.

Growth of Colpidium in Relation to Certain Incomplete Proteins and Amino Acids.—Hall and Elliott (*Arch. f. Protistenk*, 1935, **85**, 443) have demonstrated that growth of Colpidium is accelerated by several amino acids and asparagin when each of these substances is added to a medium which supports a relatively slow but steady growth of ciliates. The addition of a series of single amino acids and asparagin to a gelatin medium produced increases in growth ranging from 20% to more than 50% than in the gelatin controls. These authors therefore suppose that Colpidium is able to make use of a number of single amino acids, although none of them alone is adequate for growth of the ciliates. A combination of gelatin and a very small amount of yeast extract or liver infusion or tryptone supports the growth of ciliates continuously which does not happen in gelatin alone.

M. K. S.

Studies on the Physiology of the Euglenoid Flagellates. V. The Effect of Certain Carbohydrates on the Growth of *Euglena gracilis* Klebs.—The effect of various carbohydrates upon the growth of *Euglena gracilis* in bacteria-free culture has been studied quantitatively (Jahn, *Arch. f. Protistenk*, 1935, **86**, 238). When transferred from an inorganic medium to one containing carbohydrate in addition to inorganic substances *E. gracilis* undergoes encystment or an acceleration or deceleration of division rate. The effect varied with the carbohydrate used and also to some extent by the physiological condition of the stock cultures, intensity of light, temperature and the pH of the medium. *E. gracilis* does not secrete sucrase or amylase.

M. K. S.

Isolation of *Glaucoma ficaria* Kahl in Bacteria-Free Cultures, and Growth in Relation to the pH of the Medium—Growth of *Glaucoma ficaria* occurs within the pH range of 4.9–9.5 and that of *G. piriformis* within the range of 4.0–8.9 (Johnson, *Arch. f. Protistenk*, 1935, **86**, 263). In general the pH optimum is somewhat lower for *Glaucoma piriformis* (4.8–5.3) than for *G. ficaria* (5.1–6.0). The type of growth-pH curve for either species depends upon the type of medium used.

M. K. S.

Growth of *Glaucoma ficaria* Kahl in Cultures with Single Species of Other Micro-Organism.—Johnson (*Arch. f. Protistenk*, 1936, **86**, 359) has successfully cultured *Glaucoma ficaria* in suspension of 21 species of living bacteria, one species of living yeast, and one species of algæ; in suspension of 11 species of dead bacteria, a species of dead yeast and 6 species of dead flagellates. The usefulness of yeast and small Protozoa as food for *G. ficaria* depend largely upon the size of such organisms, the larger forms not being ingested by the ciliates. In suspensions of Bact. (Erythrobacillus) prodigiosus the division rate of *G. ficaria* was approximately the same from pH 4.5 to pH 8.6 while in suspension of three other species of bacteria the ciliates showed a bi-maximal growth-pH curve with maximal development at pH 5.0 bis 5.2 and at pH 7.6.

M. K. S.

Nutrition and National Health.*

IN his three Cantor Lectures Sir Robert McCarrison expounds, with clarity and eloquence, the faith of the modern student of nutrition. He is not the type of scientific worker who ignores the wood in contemplation of the trees, or of a particular leaf on a particular branch of a particular tree. He never loses sight of the fundamental fact that well fed animals are strong and healthy and largely escape disease, while badly fed animals have a low vitality and poor physical development, and suffer from all manner of diseases which orthodox medicine ascribes to multifarious causes. It is an interesting reflection that hitherto man has not succeeded, except perhaps in rare instances, in achieving a thoroughly satisfactory adaptation to his environment in the matter of food. The "natural" diet of the savage is far from ideal; that of the grain fed peasant, who still forms the majority of the human race, still less so. Even the pastoral peoples do not achieve dietary perfection. Civilisation was made possible by the discovery and cultivation of cereal and leguminous plants producing food which can be stored in bulk. But plant seeds, even when unmilled, are not entirely suited to form the whole food of the human organism. The perfect human diet, in the modern sense, includes in addition to seeds a food which seems quite "unnatural," the milk of another species, and vegetables and fruits which have come into common use only in the last few centuries and which until quite recently were scanty except in certain seasons. The human infant in the temperate zone seems to require, for optimum development, a substance —vitamin D—obtained by organised industry from the liver of fish or produced by the artificial irradiation of foods. A perfectly nourished people would be a *new* creation, as much a product of experimental and applied science as television is a product of experimental and applied science. It would represent adaptation to environment on a different plane to that hitherto attained by man in his struggle to obtain enough food for mere survival.

Sir Robert McCarrison has done as much as any man to further this adaptation. In his lectures he describes various experiments which have led us to a realisation of the importance of proper diet. One striking experiment which was carried out in Coonoor is described.

"Many years ago (1918) when the newer knowledge of nutrition was in its infancy, I obtained some dozens of healthy monkeys from the jungle of Madras. Some I fed on faulty and ill-balanced food deficient in vitamins and mineral elements, others on perfectly constituted food. The latter remained in good health; the former developed gastro-intestinal ailments, ranging from gastritis and ulcer to colitis and dysentery, while one amongst them had a commencing cancer of the stomach. The passage of years has not dimmed the recollection of this crucial experiment nor detracted from the far-reaching importance of the results yielded by it. Indeed, there is, perhaps, no more significant fact in regard to the function of nutrition than that this highly specialised alimentary mechanism on which the nourishment of the body depends is itself among the most susceptible of the structures of the body to faulty nutrition."

(It is said that the descendants of the monkeys used in this experiment, or of those which survived to be subsequently liberated, still roam the woods and jungles in the neighbourhood of Coonoor. But that is by the way.)

The third lecture of the series deals with nutrition in relation to national health. The lecturer points out that in England standards of health and physique are far from satisfactory and that great improvement might follow the increased consumption of "protective" foods such as milk and green vegetables. He quotes the experience of Sir Pendrill Varrier-Jones at the Papworth Village Settlement for the subjects of tuberculosis "In this village of 400 persons no child born there during the twenty years of its existence has, while a member of the community, contracted tuberculosis of the lungs, bones, joints, cerebral membranes, nor indeed any clinical form of the disease. Yet these children are the offspring of parents who suffer from tuberculosis and are in constant contact with them." One of the most important factors in bringing about this remarkable result is that the diet of young children born in the village has been carefully supervised.

Sir Robert McCarrison declares that Miss Margaret McMillan's book *The Nursery School*, which describes the regeneration of children of the poorer classes by good feeding and careful management, should be "an obligatory text-book for every student of medicine." He conveys here and there the suggestion that orthodox medicine, as taught in the medical schools, has been slow to adapt itself to changing views about health and disease. The now obvious fact that a large proportion of disease has its primary cause in poverty, which is associated with all manner of environmental stresses and in particular with diet deficiency, should certainly be more generally realised. Improvement in the health of a people runs parallel with improvement in their economic condition. The efficiency or otherwise of curative medicine is a factor of minor influence, however important it may be to the comfort and happiness of the individual.

W. R. A.

* "Nutrition and National Health." Major-General Sir Robert McCarrison, C.I.E., M.D., D.Sc., LL.D., F.R.C.P. Cantor Lectures. *The Journal of the Royal Society of Arts*, 1936, **34,** 1047–83, 1087–1106.

World Production of Mineral Oils.

THE increasingly important role which mineral oils have assumed in the life of Nations, in peace and in war, coupled with the periodic prophesies in the daily press of an impending petrol famine, lend interest to a sober analysis of the present situation by Dr. Oscar Zaepke in *Forschungen und Fortschritte* (1936, **16**, 209). Dr. Zaepke finds that while the mineral oil output of the world sank from 211 million tons in 1929 till 1932, it rose again gradually to 209 million tons in 1934 and to 226 million tons in 1935—the highest annual output in world production. The important mineral oil producing countries of the world and their individual quotas during the peak year (1935) make very interesting reading.

Dr. Zaepke considers that any estimate of the available total supplies in the world for future use would be misleading for a number of reasons. The potential oil fields of the world have as yet not been completely surveyed. The technique of tapping is continually improving till, to-day, it is possible to tap very nearly *all* the oil in a given locality. Further, progress in other branches of applied science, as for example the development of the Bergius, Franz Fischer, and Tropsch processes, are continually enriching the amount of raw material from which petrol or its substitutes can ultimately be obtained. These facts lead Dr. Zaepke to deprecate unwarranted attempts to create scares about the world mineral oil position.

The geographical distribution of mineral oil is, however, quite another matter and cannot be fully gone into here. At one end of the picture is England who must cover her enormous demand exclusively by imports and at the other end is Venezuela whose (nearly) entire production is dependent on export.

EMMENNAR.

WORLD PRODUCTION OF MINERAL OILS.

(*In* 1,000 *Tons*.)

Country	1935	%	1934	%	1933	%
U. S. A.	135 487	59·9	123 693	59·2	123 266	62·3
Russia	24 005	10·6	24 151	11·5	21 434	10·8
Venezuela	22 211	9·8	20 427	9·8	17 553	8·9
Rumania	8 359	3·7	8 473	4·1	7 387	3·7
Iran (Persia)	7 480	3·3	7 537	3·5	7 086	3·6
Dutch East Indies	6 000	2·7	5 971	2·8	5 392	2·7
Mexico	5 956	2·7	5 614	2·7	5 000	2·6
Iraqu	3 550	1·6	861	0·4	118	0·1
Columbia	2 643	1·2	2 477	1·2	1 849	0·9
Peru	2 429	1·1	2 316	1·1	1 883	1·0
Argentina	2 129	0·9	1 995	1·0	1 957	1·0
Trinidad	1 672	0·7	1 583	0·8	1 385	0·7
India	1 406	0·6	1 290	0·6	1 227	0·6
Sarawak Brunei	671	0·3	660	0·3	622	0·3
Poland	515	0·2	529	0·3	551	0·3
Germany	425	0·2	315	0·2	239	0·1
Japan (incl. Taiwan)	257	0·1	245	0·1	2:3	0·1
Equador	243	0·1	259	0·1	216	0·1
Canada	187	....	89	....	150	....
Egypt	180		211		228	
Bahren Islands	171	0·3	36	0·3	....	0·2
Other Countries	143		150		139	
TOTAL ..	226 119	100·0	208 982	100·0	197 915	100·0

SCIENCE NOTES.

Central Laboratory to Evolve Standards for Drugs.—A definite step towards the standardization of drugs in India with possibilities of the tightening of control over the manufacture of spurious drugs is being taken in the establishment of a Biochemical Standardization Laboratory, for which orders have already been issued by the Government of India. (Press Note issued from the Director of Public Information, New Delhi, 6th Nov.)

The Laboratory will consist of a Bio-assay sub-section and a Pharmaceutical sub-section, and among its functions will be the preparation and maintenance of suitable standards of strength, purity and quality for drugs, and standardization of methods of analysis and test with regard to climatic and other conditions prevailing in different parts of India. The Laboratory will also act as expert referee in respect of disputed analysis of samples sent by local Governments, guide, co-ordinate and correlate the work of provincial laboratories, assay and test chemicals and drugs, and biological products such as serum and vaccines, and organo-metallic compounds at the request of Central or local Governments, and periodically issue bulletins about its progress in various branches of its activities, and supply information to manufacturers and Provincial laboratories as the need may be.

The Laboratory will, to commence with, be located at the All-India Institute of Hygiene and Public Health, Calcutta, and Bt. Colonel R. N. Chopra, C.I.E., I.M.S., Director, School of Tropical Medicine, Calcutta, will be responsible for its organization and direction in the early stages.

The staff of the Laboratory will consist, besides a number of assistants, in its Bio-assay sub-section of one Pharmacologist, two experimental Assistants, and in its Pharmaceutical sub-section of one Pharmaceutical Chemist, one Bio-chemist and two Assistant Chemists, and steps have already been taken for their recruitment.

It may be recalled that in March 1927, a resolution was adopted by the Council of State recommending that local Governments should be urged to take steps to control the indiscriminate use of medicinal drugs and for the standardization of the preparation and for the sale of such drugs. Accordingly, in consultation with the local Governments, a Committee was appointed, presided over by Bt. Colonel Chopra, to explore and define the problem of drug control and to make recommendations. The recommendations of this Committee were considered in consultation with the Local Governments, and action is now being taken to implement them.

* * *

Central Board of Irrigation, 7th Annual Meeting.—His Excellency the Viceroy opened the proceedings of the annual meeting of the Board, on the 31st October. In the course of his speech, His Excellency dealt with the importance of irrigation research in relation to the agricultural prosperity of the country. "We are all of us proud to think that India should possess an irrigation system which is the most important in the world to-day and I would like to take this opportunity to pay my tribute to the long line of distinguished engineers to whose labours that system is due, and who can claim to have contributed in the most material degree to laying the foundations of India's prosperity." The total amount so far expended on irrigation works approximate to Rs. 150 crores. That sum has been spent over a period of 80 years, and the system now serves an area which raises crops valued at more than 100 crores of rupees, annually.

Of the problems of vital importance to India to-day, not the least important is that of the food for her rapidly increasing population. According to a recent report of the Public Health Commission with the Government of India, the population of India is increasing at the rate of about 4 millions every year, and it is expected that by 1941 the population of India will be 400 millions! Only three-fourths of an acre per head of population in British India is under cultivation for food purposes, and while the Agricultural departments are investigating the means of increasing the productivity of the land, it will become apparent to every one that to keep pace with the increase in population large tracts of land must be brought under fruitful cultivation, and this can be effectively done by extending facilities for irrigation.

A recent development in the country and one of great importance is that of hydro-electric generating schemes on irrigation canals by the utilisation of power available at canal falls. Extraction of water from the sub-soil for the irrigation by means of electrically operated tube-wells is being undertaken on a large scale. The Ganges Canal Hydro-Electric Scheme in the United Provinces commands an area of 13,000 square miles and is capable of supplying electric power at cheap rates, primarily for irrigation and agricultural purposes.

One of the questions that came up for discussion at the meeting is that of the establishment of a Central Research Station for Irrigation. The work of the past ten years on problems of irrigation and river control with the use of models has shown the need for research of an all-India character. The establishment of such an Institute will be a matter of great importance to the progress of irrigation in India.

* * *

Meteorology in India.—Details of rapid strides made during the last twelve months and even more important developments pending are given in the Administration Report of the Meteorological Department of the Government of India for 1935–36.

Dealing with the Empire Air Mail Scheme, which is expected to come into operation during the next two years (according to a press note issued by the Director of Public Information). The Report states:—"At important stations along the route it will probably be necessary to maintain a service throughout the twenty four hours, and at all intermediate stations for fifteen hours or more.

"The development will involve sending up illuminated balloons for the measurement of upper winds at night, search lights for determination of cloud heights, special arrangements for measurements of visibility at night, and provision of extra staff for night attendance.

"Night flying involves more or less blind flying, in which airmen need all the help they can get to navigate their machines safely, and in countries where night flying has developed to a considerable extent, such as Germany and the United States of America, there are meteorological stations on the routes 50 or 60 miles apart; in India, however, financial considerations will permit stations only at intervals of about 300 miles."

It is pointed out that air traffic has become regular between India, Siam, Malaya and Indo-China, and that the exchange of meteorological data with these and other countries has, therefore, become a problem of considerable importance. A regular broadcast of weather data from a powerful wireless station is necessary. It is noted that short-wave stations are being established at Rangoon and Calcutta, and that these will solve that problem.

In connection with the aviation weather service the Report states :—"The existing meteorological organisation in India for aviation is still far below the standard defined in the International Convention.

Progress was made in the study of the detailed distribution of rainfall in South India associated with storms. A new forecasting formula for winter rains, which promises to be an improvement, has been worked out by utilising the upper wind data of Agra.

The comparatively new section of Agricultural Meteorology is to be continued for a further period of two years for the present. Valuable investigations have been made in this section on the movement of moisture and heat through the air and soil, of solar and terrestrial radiation and other problems. Special attention was directed to problems relating to frost and cold wave warnings.

Another small but important activity is the co-operation with the Locust Research Entomologist which involves the supply of meteorological data required and the arrangement of frequent discussions about weather conditions.

It is interesting to note that besides the multifarious routine activities, the Department has had time to tackle a large number of research problems. A long list of such problems which received attention during the year is given—most of these are of considerable importance to the science of meteorology. Some of these researches are of immediate value to the utilitarian activities of the department.

* * *

Indigenous Tool Handles.—The annual consumption of Tool Handles by the Indian Railways and Government departments alone is estimated by the Imperial Forest Economist at some 2,000,000 handles. The bulk of this huge demand is met by import (mostly ash and hickory). The possibility of meeting at least part of this demand with indigenous woods is, therefore, of importance. Mr. M. N. Gallant, I.F.S., Forest Economist, Burma, gives an interesting account in *The Indian Forester* (October 1936) of the successful efforts made to introduce to the market Tool Handles of *Anogeissus acuminata*.

Preliminary experiments at Dehra Dun in 1925 indicated that *Anogeissus acuminata* was possibly superior to imported ash and hickory. During 1926–30, Tool Handles from kiln-dried *Anogeissus acuminata* were supplied, for test under work conditions, to the Great Western Railway, the Federation of British Industries and others in England. Much headway against conservatism and prejudice had to be made and it was not until 1933 that the South Indian Railway placed an order for a modest 3,000 handles of the wood. The same year the E. I. R. purchased 37,700 handles and since then the popularity and the demand for these Tool Handles have slowly but steadily developed. The Railway Board, Delhi, impressed by the very favourable reports from the consumers, are now investigating the possibility of erecting a large plant near Calcutta for supplying the requirements of several Indian Railways for these Tool Handles.

These pioneer efforts may be said to mark a new chapter in the utilisation of indigenous woods for Tool Handles in India.

EMMENNAR.

* * *

London Shellac Research Bureau.—We have recently received a copy of the *Annual Report* for the year 1935–36. The report commences with a frontispiece of the attractive window display at India House of the several articles arising out of lac. The fluctuations in the lac market are shown to be within narrow limits by the figures in the table of monthly imports and prices. Reference is made to the increased consumption of lac in Russia and Japan.

From the brief description of the work of the Special Officer, Lac Inquiry, it is quite evident that strenuous efforts have been made to further the causse of lac by propaganda in person and through the technical press. Great emphasis is laid on the marketing of genuine lac, conforming to a standard specification and the distribution of knowledge on the uses of lac. The rather alarming state of lac in the gramophone record industry is disclosed and it is linked to the fact that the gramophone is being rapidly replaced by the radio or radiogram. Figures are given to indicate the increased output of synthetic resins but they seem not to have spelt real danger to lac as yet, because the majority of synthetic resins are used in the positive moulds and for thermosetting moulding materials where shellac has not been found suitable.

The lac research programme in the United Kingdom is briefly outlined and reference has been made to the progress achieved in the various lines. It is pointed out that the co-ordination of the work of the London Shellac Research Bureau with the Indian Lac Research Institute and the New York Shellac Research Bureau could be enhanced by periodical meetings of the executives, instead of by mere correspondence.

It is gratifying to find from the report that the year under review has been a period of great activity and good deal of work has been carried out to stabilise the position of lac in the world market.

* * *

Rothamsted Experimental Station.—It is a pleasure to have the opportunity of recording another year of useful and intensive research in the several branches of agricultural science, carried on at the Rothamsted Experimental Station, Harpenden, England. The comprehensiveness of the subjects taken up for scientific

study at this centre, the oldest of its kind in the world, is evident from their *Report for* 1935, just received, which states that "the range of investigations includes the growth and composition of crops, the properties of soils, of fertilizers and manures, the conditions in which each can be used to the best advantage, soil management, plant diseases, insect pests, bees and other subjects." Though the Station first came prominently into public notice through its advocacy of the value of artificial fertilizers and its famous permanent manurial experiments on wheat, roots and barley, its activities have, since their inception in 1843, shown an ever widening horizon and at the present time much work of a purely scientific character is carried on in the several laboratories attached to the Station. In fact, the scientific reputation of the institution is so high that it has been attracting, year by year, leading agricultural workers and scientists from all parts of the world, who have found in Rothamsted a quiet haven best suited for intensive scientific studies.

It would appear from the *Report* that the results of 50 years' experimental work completed at Woburn from 1877 till 1928 are under publication, and the work of the Microbiology Department at Rothamsted has recently been published in a monograph entitled " Problems in Soil Microbiology " by Mr. Cutler and Miss Crump. Dr. Brenchley contributes to the present *Report* a useful summary of the last 30 years' work in the Botanical Department. One anticipates that the occasion of the centenary celebration of the Experimental Station in 1943 will be availed of by the authorities to place before the public comprehensive accounts of the work carried on by the Institution, since its inception, in the several branches of agricultural research in which the Station has been interesting itself.

The general arrangement of matter and get-up of the *Report* follows the lines of the previous volumes. One would however be surprised to note that the introductory part makes no reference to the recent purchase by the Station of the Rothamsted Estate and Manor House at a cost of £35,000 raised by public subscriptions. Recent visitors to Rothamsted will also miss in the engraving of the Laboratory given in the *Report* the Sun Dial which was prominently fixed in front of the main building last year.

C. N. A.

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The recent issue of the *Quarterly Journal of the Mining, Geological and Metallurgical Society of India* (Vol. VIII, No. 2) contains two articles on the heavy minerals of the Barakar and Raniganji sandstones of the Jharia coal fields. K. L. Bhola in the first article has described the heavy minerals, and has tried to correlate them with the granites, pegmatites and the garnet schists of the area. In the second article S. K. Roy and N. L. Sharma have published the results of the heavy mineral analysis of a number of samples. They have been tabulated and a geological map at the end shows the localities of the samples collected.

The council of the Mining and Geological Institute of India appointed in the year 1929 a Committee to go into the causes of subsidences and underground fires in coal fields. During the years 1929 to 1936 the Committee has collected a large amount of information from various collieries and mines in India. Very valuable geological data about dykes and faults affecting coal seams have also been reported. There are numerous sketches, sections and figures appended to the report which must be very helpful for all mining engineers and colliery managers.

* * *

The Journal of the Indian Medical Association.—With the publication of the September Number, the *Journal of the Indian Medical Association* completes the fifth volume. As its name indicates, it is the official organ of the Association and is issued monthly from Calcutta under the Editorship of Sir Nilratan Sircar, KT., M.A., M.D., LL.D., D.C.L. The Association has a number of branches in the important centres of India, Burma and Ceylon, and a number of professional societies are affiliated to it. The Journal has a wide circulation consistent with its reputation. The number under notice contains an article by Drs. J. C. Gupta and S. K. Sen on the behaviour of Free HCl Curve in a Series of 100 consecutive cases of Gastric Content Analysis, with the idea of obtaining a clue for diagnosis. Dr. S. P. Gupta has contributed an article on the Hodgkin's Disease which manifest itself as a progressive glandular enlargement and as the diagnosis of this condition mostly rests on histological and biological examinations and as the facilities for these tests are not usually within the reach of general practitioners, the extent of this malady has not been gauged. There are other interesting articles including the one on Birth Control in India by Dr. A. P. Pillay, the Editor of *Marriage Hygiene*. Other features include, Case Notes, Notes from Current Medical Literature, Medical Notes and News, Association Notes and Book Reviews. We have no doubt that the Association with its useful activities has an assured future.

* * *

'Marriage Hygiene.'—This International Quarterly Journal of Sexology, issued under the Editorship of Dr. A. P. Pillay, has during the past two years of its existence published in its pages articles of international character, and has proved a real addition to the literature on Sexology. Its objects are (1) To secure for conjugal hygiene a proper place in preventive medicine by setting forth its significance and interactions on personal, domestic and social life and its importance for racial and national welfare. (2) To publish scientific contributions treating marriage as a social and biological institution, considering especially the factors and forces influencing its welfare. The problem will be discussed from the view-point of physiology rather than pathology and the emphasis will be on the normal rather than abnormal functions. The sociological, economic and legal aspects will not be neglected. (3) To promote, co-ordinate and unite the interests of contraceptive clinics and marriage hygiene consultation centres in various parts of the globe.

We understand that at the instance of Dr. Havelock Ellis, the editors have decided to enhance the scope of the Journal, by publishing in it special articles bearing on Sexology. The annual subscription of the Journal is Rs. 10, and we hope that this useful Journal will receive all the support from the scientists, it so richly deserves.

Royal Asiatic Society of Bengal.—At the ordinary meeting held on 7th December, the following papers were read: (1) A. Banerji, *A Buddha Image from Kurkihdr*; (2) A. H. Harley, *Abu Nukhailah, A post-classical Arab Poet*; (3) S. N. Chakravarti, *A Sculptural Lintel of Gupta Date from Sarnath*; and (4) G. E. Gates and M. Hla Kyaw, *The Clitellum and Sexual Maturity in the Megascolecinoe*. The following exhibits were shown and commented upon: (1) *Little-known Works of Two Celebrated Tantric Writers*, and (2) *A Valuable Manuscript of an Urdu Romantic Poem (Mathnawi)* composed by Sharaf-un-Nisa a lady of Murshidabad (Bengal).

* * *

The Nobel Prize in Physics for this year has been divided between Prof. V. Hess and Dr. C. Anderson. Prof. Hess discovered that the ionisation of air at an altitude of 5,000 meters was more than twice that found at sea-level, showing thereby that this ionisation was of interstellar or cosmic origin. Dr. Anderson is the celebrated discoverer of the positron, the antithesis of the electron.

The Nobel Prize in Chemistry has been awarded to Prof. Peter Debye, the well-known Mathematical Physicist, for his researches bearing on the structure of molecules.

* * *

Mr. T. E. Parkinson, I.E.S., Director of Public Instruction, Punjab, has been appointed Educational Commissioner to the Government of India.

* * *

Official intimation has been received that the Senate of the London University at their meeting of 18th November 1936, conferred the degree of Doctor of Science on Dr. H. Chaudhuri, Head of the Department of University Teaching in Botany, and Director, Kashyap Research Laboratory, Punjab University.

* * *

New Research on Optical Glass at Mellon Institute.—A broad program of fundamental investigations on the chemistry and physics of glass surfaces to aid in the development of scientific apparatus and ophthalmic instruments has been started at Mellon Institute of Industrial Research by the Bausch & Lomb Optical Company, of Rochester, N.Y. The first studies will be concerned with the effects of environmental factors on the durability of the various types of glass used in optical instruments.

The Bausch & Lomb Optical Company, whose research in optical glass dates from the initial work of William Bausch in 1912, has maintained a fellowship at Mellon Institute since 1931 for research on various plant and production problems in optical technology. New developments in the past have included improved greases for optical instruments, cements for ultra-violet transmitting optics, improved methods for making and testing mirrors and reflectors, and standardization of the sizes of fine abrasives used in grinding lenses.

Dr. Frank L. Jones, the fellow since 1931, will be in charge of the new investigations of the Bausch & Lomb Optical Company at Mellon Institute. An enlarged staff will continue the work on plant problems at the new research laboratory of the company in Rochester.

* * *

Micromax Thermocouple Pyrometres.—A new 52-page catalog has been just issued by Leeds & Northrup describing "Micromax Thermocouple Pyrometers". The potentiometer method of measurement of the operation of the rugged, yet simple, mechanisms through which this balance method is made available to industry are well explained.

The new Silver-Anniversary Micromax, announced in the 25th year since this Company originated the recording potentiometer, is described in detail. This thoroughly modern machine keeps always visible ten inches of record, while a bold pointer enables the operator to read temperature at a glance. The instrument can be equipped also to operate signals and automatic controls, and is available for measuring not only temperature but CO_2, liquid level, valve position, speed, smoke density, chemical strength, pH, frequency, load, voltage, etc.

Set forth for ready comparison is the complete line of Micromax instruments which offers the pyrometer user appropriate models to indicate, to record, to signal, to control or to perform these functions in any desired combination.

This new catalog contains a wealth of information which everyone who uses or specifies pyrometers will want. To receive a copy, write for Catalog N-33A, Leeds & Northrup Company, 4934 Stenton Avenue, Philadelphia, Pennsylvania.

* * *

Announcement:

"The Genoms of *Triticum Timopheevi* Zhuk., *Secale cereale* L. and *Haynaldia villosa* Schur.," by Dontcho Kostoff.

Our attention has been recently drawn by the author to an unfortunate error in the article which appeared in the August Number of this Journal, under the title "The Genes of *Triticum Timopheevi* Zhuk., *Secale cereale* L. and *Haynaldia villosa* Schur." Throughout the text the word *genom* which occurred in the original article has been changed to *gene*. The author points out "a very serious mistake has been made in changing the word *genom* to *gene*. *Gene* is the hereditary unit while *genom* means all the *genes* together an organism has in its haploid set of chromosomes." As this change occurs throughout the text, we hasten to draw the attention of our readers to this most regrettable mistake."

Ed.

* * *

We acknowledge with thanks receipt of the following:—

"Actualités Scientifiques et Industrielles," Nos. 330–342, 363–366, 373–374, 399–400.

"The Agricultural Gazette of New South Wales," Vol. XLVII, No. 11, November 1936.

"Journal of Agricultural Research," Vol. 53, Nos. 5 and 6, and Index to Vol. 52.

"The Philippine Agriculturist," Vol. XXV, No. 6, November 1936.

"The Allahabad Farmer," Vol. X, No. 6, November 1936.

"Journal of the Royal Society of Arts," Vol. LXXXIV, Nos. 4379–4382.

"Biochemical Journal," Vol. 30, No. 10, October 1936.

"Journal of the Indian Botanical Society," Vol. 15, Nos. 5 and 6, October and December 1936.

"Chemical Age," Vol. 35, Nos. 904–907.

"Journal of Chemical Physics," Vol. 4, No. 11, November 1936.
"Journal of the Indian Chemical Society," Vol. 13, No. 9, September 1936.
"Berichte der Deutschen Chemischen Gesellschaft," Vol. 69, No. 11.
"Journal de Chimie Physique," Vol. 33, No. 10.
"Experimental Station Record," Vol. 75, No. 4, October 1936.
"Transactions of the Faraday Society," Vol. XXXII, Part II, November 1936.
"Indian Forester," Vol. LXII, No. 12, December 1936.
"Forschungen und Fortschritte," Vol. 12, Nos. 31–33.
Government of India Publications:—
"Monthly Statistics of Production of Certain Selected Industries of India" (Department of Commercial Intelligence and Statistics), No. 5 of 1936–37, August 1936.
"Diseases of Sugarcane and Methods for their Control," by L. S. Subramaniam, Bulletin No. 10, 1936. (Imperial Council of Agricultural Research.)
"Indian Meteorological Department Scientific Notes: A Report on the Administration of the Meteorological Department to the Government of India in 1935–36."
"Indian Trade Journal," Vol. CXXXIII, Nos. 1586–1589.
"The Calcutta Medical Journal," Vol. 31, Nos. 4 and 5, October and November 1936.
"Medico-Surgical Suggestions," Vol. 5, No. 11, November 1936.
"Review of Applied Mycology," Vol. 15, No. 10, October 1936.
"Forest Research in India," 1935–36. Part I. The Forest Research Institute.
"Annual Report of the London Shellac Research Bureau for the year 1935–36."
"Carnegie Institution of Washington Bulletin," Vol. IV, No. 8.
"Journal of the American Museum of Natural History," Vol. 38, No. 4, November 1936.
"Nature," Vol. 138, Nos. 3495–3498.
"Journal of Nutrition," Vol. 12, No. 4, October 1936.
"Science and Culture," Vol. II, No. 5, November 1936.
"Arkiv fur Zoologie," Vol. 28, No. 3, 1936; Vol. 28 A, No. 17, 1936.

Catalogues:

"Mitteilungen über Neuerscheinungen und Fortsetzungen, 1936," No. 5 (Messrs. Verlag Von Gustav Fischer in Jena).
"Books on Astronomy and Mathematics" (Messrs. Wheldon & Wesley, Ltd., London).

ACADEMIES AND SOCIETIES.

Indian Academy of Sciences:

October 1936. SECTION A.—B. L. GULATEE: *On the Variation of Latitude at Dehra Dūn.*—The diurnal and annual terms in the variation of latitude are discussed. K. C. SUBRAMANIAM: *The Diamagnetism of Some Metallic Halides.*—With zinc, cadmium and mercury halides, there is a general increase in susceptibility when the salts are dissolved in water or methyl alcohol. This is attributed to the release of deformation of the ions of the molecule by the action of the solvent to the extent of ionisation. C. S. Venkateswaran: *The Raman Spectra of Sulphur and Phosphorus. Part II.—Lattice Oscillations.*—An intense sharp line at 36 cm. for solid phosphorus and at 80 cm. for rhombic sulphur are attributed to lattice oscillations. P. NILAKANTAN: *The Magnetic Anisotropy of Rhombic Sulphur.*—The data are in general agreement with results of X-ray measurements. M. K. PARANJPE: *The Convection and Variation of Temperature near a Hot Surface. Part I.—The Dust-Free or Dark Layer in Relation to Surface Convection.*—The formation of a dark or dust-free layer in a space between a hot surface (above) and a cold surface (below), is discussed. B. S. MADHAVA RAO: *Semi-Vectors in Born's Field Theory.* RAM KUMAR BOUNTRA AND KANTILAL C. PANDYA: *The Acid Content of Some of Our Vegetable Foodstuffs. Part II.—Amchur or* Mangifera Indica.—Three organic acids, tartaric, citric, oxalic, have been found in proportion 6, 4, and 1% respectively. CH. V. JOGARAO: *An Optical Investigation of Some Indian Oils. II.—Raman Effect.* V. T. CHIPLONKAR: *The Relative Efficiencies of the Multistage and One Stage Process in the Electrolytic Preparations of Heavy Water.*—Compared with a single stage process, there will be no loss in efficiency if fresh-water is added continuously. R. R. KHANOLKAR, P. M. BARVE AND B. N. DESAI: *Condition of Sparingly Soluble Substances in Gels. Part I.—Silver Chromate in Gelatine.*—Changes in the conductivity and colour of Silver Chromate in gelatine solution have been studied. G. F. MANKODI, P. M. BARVE AND B. N. DESAI: *Importance of Dialysis in the Study of Colloids. Part III.—Colloidal Prussian Blue.*—The changes in cataphoretic speed and viscosity under different conditions show that neither the views of Dhar nor of V. Smoluchowski can individually explain the results. HANS RAJ LUTHRA AND DR. V. I. VAIDHIANATHAN: *Uplift Pressures under Weirs with Three Sheet Piles.*—Working results have been obtained for the design of weirs with three sheet piles.

November 1936. — SECTION A. — B. N. ACHARYA, A. M. PATEL and B. N. DESAI: *Conductivity and Cataphoretic Speed Measurements of Benzopurpurin 4B, Congo Red and Sky Blue F.F.*—The changes observed with concentration are explained on the basis of aggregation of the dye ions to form micelles. B. Y. OKE: *Lattice-Theory of Alkaline Earth Carbonates. Part II.—Elasticity Constants of Aragonite. Part III.—Lattice Energy of the Crystals of Calcite and Its Thermo-Chemical Applications.* B. R. SETH: *On the Flexure of a Hollow Shaft—I.* P. NILAKANTAN: *Magnetic Anisotropy of Naturally Occurring Substances. II. Molluscan Shells.*—The crystalline character of the elements as well as their regularity of arrangement have been established and the probable orientations deduced. E. GORA: *On Fermi's Theory of β-Decay.* S. PARTHASARATHY: *The Visibility of Ultrasonic

Waves in Liquids.—It is shown that the Heidemann effect repeats at intervals of $d = \lambda^{*2}/2\lambda$ for standing waves, in agreement with the theory of Nagendra Nath. A simple method of deriving the periodic visibility is given as an Appendix by N. S. N. Nath. K. SUBBA RAO AND B. SANJIVA RAO: *Studies in Adsorption on Gels. I. A Comparative Study of Selective Adsorption from Binary Mixtures of Liquids on Gels of Silica, Alumina and Ferric Oxide*.—The chemical nature of a gel markedly affects selective adsorption from binary liquid mixtures. H. GUPTA: *On Sums of Powers*. B. S. MADHAVA RAO: *Complex Representation in Born's Field Theory*. C. B. JOSHI, P. M. BARVE AND B. N. DESAI: *Importance of Dialysis in the Study of Colloids. Part IV. Colloidal Arsenious Sulphide*.—The results are complicated by changes in the composition of the sol. B. ANAND: *Raman Effect in Dibasic Acids in Crystalline State*.—A technique is described for studying Raman Spectra of Crystalline and Amorphous Solids. Results for the first three members of the oxalic acid series are given.

October 1936.—SECTION B.—MANECK B. PITHAWALA: *A Geographical Analysis of the Lower Indus Basin (Sind). Chapter I. Physiography. Chapter II. The Indus—Its History, Regimen and Physics*.—The physiography of Sind has been dealt with especially with regard to the problems of water-supply, economic resources, industrial possibilities, population, etc. The origin of the Indus Basin has also been discussed. The second chapter deals with the geological and recent history of the principal water course of the land, *viz*., the Indus River. Appropriate maps, sketches, graphs, and charts have been provided and the study constitutes the first pioneering attempt to analyse the geographical features of an Indian Province.

November 1936.—SECTION B.—B. S. KADAM: *Genetics of the* Bansi *Wheat of the Bombay-Deccan and a Synthetic Khapli—Part I*.—The inheritance of pubescence of glumes, colour of grain, colour of glumes, and colour of awns and their interactions is reported. A. VENKATASUBBAN, (MISS) R. KARNAD AND N. N. DASTUR: *Urease Activity of Germinated Seeds*.—Germination of urease-containing seeds brings about the solubilisation of the *desmo* enzyme present in the seeds. B. N. SINGH AND B. R. SINGH: *Growth and Water Requirement of Crop Plants in Relation to Soil Moisture*.—The transpiration rate is analysed with special reference to the growth and water requirements of the plants. The plants studied have either two or three critical periods located in seedling, pre-flowering and ripening stages, when they require a very large amount of water. These periods cover varying number of days in different crops. FROILANO DE MELLO AND (MISS) CIRIACA VALES: Hœmogregarina thyrsoideæ *N.Sp., Parasite of the Indian Eel* Thyrsoidea macrurus *Bleeker*. M. S. RANDHAWA: *A Short Note on an Indian Variety of* Sphæroplea annulina *(Roth.) Agardh, Var.* multiseriata *Var. Nov. A New Species of* Cylindrocapsa *from India*. M. S. RANDHAWA: Cylindrocapsa œdogonioides *sp. nov.* G. N. RANGASWAMI AYYANGAR, K. KUNHI KRISHNAN NAMBIAR AND P. KRISHNASWAMY: *Studies in* Dolichos lablab *(Roxb.) and (L.)—The Indian Field and Garden Bean. III*.—In field varieties of *lablab*, there are seven purple pigmented and one green type. Along with the four seed coat colours, Black, Chocolate, Khaki and Buff, there results sixteen genotypes. These arise by the interaction of four factors K, P, Ch and I, of which K is the basic factor for the seed coat colour series. Data from 160 segregating families are presented in support of the above interpretation.

The Indian Physico-Mathematical Society (*Journal*, 7, No. 2):

S. C. DHAR: *On the Uniformisation of Algebraic Curves of Genus Four:*

The differential equation

$$y'' + \frac{3}{16}\left[\frac{f'(z)}{f(z)} - \frac{2n+2}{2n+1}\,\frac{f''(z)}{f(z)}\right] y = 0$$

where $f(z) = (z - e_1)(z - e_2) \ldots (z - e_{2n+2})$, occurs in connection with the determination of a variable t such that $s = s(t)$, $z = z(t)$ where $s^2 = f(z)$ and $s(t)$, $z(t)$ are single-valued functions. It is known that t is the quotient of any two solutions of the differential equation. The author shows in this paper that the uniformising variable for the curve $s^2 = 1 + z^9$ which is of genus 4, admits of a Fuchsian group of transformations, and mentions that in a communication to the London Mathematical Society he has proved the result for a curve of any genus belonging to the above type.

RAM BEHARI: *On Levi-Civita's 'Anormalita' of a Rectilinear Congruence:*

Considering a rectilinear congruence in which a typical line passes through (x, y, z) and has direction cosines (X, Y, Z) where x, y, z, X, Y, Z are functions of two parameters u, v, Levi-Civita's Anormalita A is defined by the equations

$$\frac{\partial Y}{\partial z} - \frac{\partial Z}{\partial y} = AX,\ \frac{\partial Z}{\partial x} - \frac{\partial X}{\partial z} = AY,\ \frac{\partial X}{\partial y} - \frac{\partial Y}{\partial x} = AZ.$$

The author has introduced in a previous paper (*J. Ind. Math. Soc.*, Vol. I (New Series), p. 135), the concept of 'pitch' of a given ray of the congruence. The pitch p is defined by $\int_C X dx + Y dy + Z dz$ where C is a closed curve on the director surface forming the boundary of an area dS cut off by a thin pencil of rays of the congruence adjacent to a given ray. In the present paper, the author proves that $\frac{dp}{d\sigma} = A\,\frac{eg - ff'}{EG - F^2}$ where $d\sigma$ is the element of area of the spherical representation of dS, and the other letters have their usual meanings in the theory of rectilinear congruences.

The Indian Mathematical Society (*Journal*, 2, No. 3):

RAM BEHARI: *Ruled Surfaces through a Ray of a Rectilinear Congruence:*

Through a line of a rectilinear congruence two ruled surfaces belonging to the congruence can be drawn so as to have any one of the properties: (*a*) They have the same central point on the line. (*b*) Their lines of striction lie on the focal sheets, (*c*) Their parameters of distribution are equal to a given constant.

Some properties of these surfaces are considered, mainly dealing with the 'pitch' of the line.

R. C. BOSE: *A Theorem on Equiangular Convex Polygons Circumscribing a Convex Curve:*

The following theorem is proved:

Given a closed convex curve V, with perimeter L and an integer $n \geqslant 3$ we can find at least two n-sided convex equiangular polygons, circumscribing V and having the perimeter $\frac{n\,L}{\pi} \tan \frac{\pi}{n}$, *i.e.*, a perimeter equal to the perimeter of a regular n-gon circumscribing a circle of perimeter L.

As a corollary, if $\overline{S}$ and $\underline{S}$ denote the maximum and minimum perimeters of n-sided convex equiangular polygons circumscribing V, then

$$\overline{S} \geqslant \frac{nL}{\pi} \tan \frac{\pi}{n} \geqslant \underline{S}$$

T. VENKATARAYUDU: *On the Significance and the Extension of the Chinese Remainder Theorem:*

The so-called Chinese Remainder Theorem is interpreted by the author as establishing a definite isomorphism between a vector modular algebra and a scalar modular algebra. An extended form of the theorem is set forth, and this is employed to determine a set of normal basis elements from a given set of basis elements of an Abelian group.

V. LEVIN: *Two Remarks on Hilbert's Double Series Theorem:*

An improved form of Hilbert's Double Series theorem (*vide* Hardy, Littlewood and Polya: *Inequalities*, Chap. IX) is given, *viz.*,

$$\sum_{0}^{\infty}\sum_{0}^{\infty} \log \frac{(m+n)^{m+n}\;(m+n+2)^{m+n+2}}{\overline{m+n+1}^{\,2(m+n+1)}}\; a_m b_n < \pi \left(\sum_{0}^{\infty} a_m{}^2\right)^{\frac{1}{2}} \left(\sum_{0}^{\infty} b_n{}^2\right)^{\frac{1}{2}}$$

where a_m and b_n are real positive numbers, all the a's or b's not vanishing.

Another theorem, again an improvement upon a known inequality, is given, *viz.*:

If

$$p > 1,\ q > 1,\ \frac{1}{p} + \frac{1}{q} \geqslant 1,\ p' = \frac{p}{p-1},\ q' = \frac{q}{q-1},$$

$\lambda = \frac{1}{p'} + \frac{1}{q'}$, then

$$\sum_{1}^{\infty}\sum_{1}^{\infty} \frac{a_m\, b_n}{(m+n)^{\lambda}} \leqslant K \left(\sum_{1}^{\infty} a_m{}^p\right)^{1/p} \left(\sum_{1}^{\infty} b_n{}^q\right)^{1/q},$$

when

K is taken as $\left(\pi \operatorname{cosec} \frac{\pi}{\lambda p'}\right)^{\lambda} = \left(\pi \operatorname{cosec} \frac{\pi}{\lambda q'}\right)^{\lambda}$.

If $q = p'$, this gives the known best value of K for this case, *viz.*, $\pi \operatorname{cosec} \pi/p$.

S. S. PILLAI: *On Sets of Square-free Numbers:*

Let $N(x) = N(x, d_1, d_2, \ldots d_{r-1})$ denote the number of groups of square-free numbers $q_1, q_2 \ldots q_r$ not exceeding x, such that $q_m - q_1 = d_{m-1}$, $(m = 2, 3, \ldots r)$. Let $f(p)$ be the number of different residue classes modulus p^2 and not congruent to 0 contained in the set $d_1, d_2, \ldots d_{r-1}$. Then it is proved that

$$N(x) = Ax + O\left(\frac{x}{\log x}\right) \text{ where}$$

$$A = \prod_{p} \left\{1 - \frac{1 + f(p)}{p^2}\right\}.$$

S. S. PILLAI: *On* $a^x - b^y = c$:

By using Aaron Herschefeld's method of proof for the special case $2^x - 3^y = d$ (*Bull. Amer. Math. Soc.*, XLII) and the results of a previous paper by the author (*J. I. M. S.*, Vol. XIX), it is proved here that when c is large the equation $a^x - b^y = c$ has at most one solution. Further, if a, A, b, B, c are given positive integers and c is sufficiently large, then the equation $Aa^x - Bb^y = c$ can have at most one solution.

J. L. SHARMA: *On Integrals Involving Lamé Functions:*

Lamé's differential equation

$\frac{d^2y}{du^2} = [n(n+1)\ \wp(u) + B]\, y$ where n is integral, admits the solutions

$$F_n(u) = \prod_{1}^{n} \left[\frac{\sigma(u + a_r)}{\sigma(u)\,\sigma(a_r)}\ e^{-u\zeta(a_r)}\right]$$

$$F_n(-u) = \prod_{1}^{n} \left[\frac{\sigma(a_r - u)}{\sigma(-u)\,\sigma(a_r)}\ e^{u\zeta(a_r)}\right]$$

Calling these functions as generalised Lamé functions, the author proves that they form a non-orthogonal set of functions.

Also, the integral of the product of any two solutions of Lamé's equation for a fixed value of n is different from zero unless both of them are of the first kind and of the same species.

Indian Mathematical Society:

The Mathematical Student, *June* 1936.——

E. H. NEVILLE: *Two Determinants.*

Let $a_1, a_2, \cdots$ and $d_1, d_2, \cdots$ be two sets of numbers, and let $a_r{}^{(s)} = (a_r + d_1)\ (a_r + d_2) \cdots (a_r + d_s)$,

Then
$$\begin{vmatrix} 1 & a_1{}^{(1)} & a_1{}^{(2)} & \cdots & a_1{}^{(n-1)} \\ 1 & a_2{}^{(1)} & a_2{}^{(2)} & \cdots & a_2{}^{(n-1)} \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ 1 & a_n{}^{(1)} & \cdots & \cdots & a_n{}^{(n-1)} \end{vmatrix} = (\zeta^{\frac{1}{2}}(a_1 a_2 \cdots a_n),$$

the product of all the differences $a_r - a_q$ with $r > q$.

If we consider a similar determinant with one absent column, *i.e.*, if F_q be a determinant with a typical row

$$[1, a_r{}^{(1)}, a_r{}^{(2)}, \cdots a_r{}^{(q-2)}, a_r{}^{(q)}, a_r{}^{(q+1)}, a_r{}^{(q+2)}, \cdots a_r{}^{(n)}],$$

then $F_q = \zeta^{\frac{1}{2}}(a_1, a_2 \cdots a_n)$

$\{A_{n-q+1} + A_{n-q}\,H_1 + A_{n-q-1}\,H_2 + \cdots + A_n H_{q-1}\}$ where $A_1, A_2 \cdots$ stand for Σa_1, $\Sigma a_1 a_2$, etc., and H_s is the sum of the homogeneous products of degree s that can be formed from $d_1, d_2 \cdots d_s$.

B. RAMAMURTI: *On the Lines of Striction of a Quadric.*—Let a central quadric be referred to its generators such that λ and μ, the parameters of the generators through any point are equal for every point on the conic section q at infinity, and let this common value be also the parameter of the point considered as a point on the conic q. If $a_x{}^4 = 0$ give the parameters of the points of contact with q of the common tangents between q and the circle at infinity Ω, then the two lines of striction are given by $a_\lambda{}^3 a_\mu = 0$ and $a_\mu{}^3 a_\lambda = 0$. The author deduces from this that the two curves intersect in ten points, six of which are the vertices of the quadric, and the other four are the points of contact of the isotropic tangent planes.

V. THÉBAULT: *On Certain Remarkable Points Connected with a Triangle.*—Certain elementary

calculations are worked out connected with the associated points and circles of a triangle. The following theorems are deduced :—

Let (α, β, γ) and $(\alpha', \beta', \gamma')$ be the centres of the squares constructed exteriorly and interiorly on the sides of a triangle ABC which is not right-angled, O the centre of the circumcircle, H′ the orthocentre of the pedal triangle A′B′C′. If we take the nine perpendiculars from (α, β, γ) or $(\alpha', \beta', \gamma')$ to the three sides of the triangle as representing nine forces, these have a resultant which is represented in magnitude and direction by the line Segment $\overline{OH'}$.

The resultant of nine forces represented by the perpendiculars from (α, β, γ) or $(\alpha', \beta', \gamma')$ to the three sides of the right-angled triangle ABC, is represented in magnitude and direction by the line segment OK′ joining the circumcentre O to its "symmetrique" K′ with respect to the Lemoine point K of ABC.

C. N. SRINIVASIENGAR: *On the Nature of Contact between $S = O$ and $S - \lambda T = O$.*—The theorem on this topic given by S. S. Pillai in *Math. Student*, Vol. III, No. 4, is proved here by a different method which is applicable to any system of Cartesian co-ordinates. The theorem is also extended to three dimensional geometry as follows, with a suitable definition of internal and external contact.

The two surfaces $S \equiv F(x, y, z) = 0$ and $S - \lambda T = 0$ where $T \equiv (x - x_1)\dfrac{\partial F}{\partial x_1} + (y - y_1)\dfrac{\partial F}{\partial y_1} + (z - z_1)\dfrac{\partial F}{\partial z_1}$, and $F(x_1, y_1, z_1) = 0$, touch each other internally or externally according as $\lambda < 1$ or $\lambda > 1$.

A. NARASINGA RAO : *On the Contact of Varieties in n-Space.*—Two varieties in $[n]$ which touch at O are defined to have external or internal contact according as every plane section of them through O but not lying in the tangent prime at O gives curves which have external or internal contact. If the contact is external for some sections and internal for others, the contact is said to be "neutral".

Let a variety in $[n]$ touching $x_n = 0$ at O be written

$$x_n = \Sigma\, a_{rs}\, x_r\, x_s + \Sigma\, a_{rst}\, x_r\, x_s\, x_t + \cdots\cdots$$

Calling $\Sigma a_{rs}\, x_r\, x_s$ as the asymptotic form of the variety at O, the author proves that two varieties in $[n]$ which touch at O have non-neutral contact when their asymptotic forms at O are either both definite or if indefinite, one is a multiple of the other. In the former case, the contact is internal or external according as the definite forms are of like or unlike sign ; in the latter, according as the numerical multiplier is positive or negative. In every other case, the contact is neutral. The author thence works out the generalisations for n-space the results of S. S. Pillai and C. N. Srinivasiengar for [2] and [3], and points out that the character of the contact is unaltered by projective transformations.

V. RANGACHARIAR : *Note on Convergence of a Certain Series* :

Consider the power series $y = a_0 + a_1 z + a_2 z^2 + \cdots$ where $zx = 1$ and $a_n\ (A + B_n) - a_{n-1}\ (C + D_n) + a_{n-2}\ (E + F_n) = 0$. For the case $A = 0, B = a_0 = 1, C + D = a_1$, the sum of the series is shown to be of the form $\left(1 - \dfrac{a}{x}\right)^{-\alpha} \left(1 - \dfrac{b}{x}\right)^{-\beta}$, where a, b, α, β are constants depending on B, C, D, E, F.

Mr. V. Ganapati Iyer explains that the solution in the general case depends on the solution of a certain differential equation of the first order, regular at $Z = O$ and taking the value $y = a_0$ when $z = 0$. S. SURYANARAYANA IYER : *A Proof of Newton's Theorem.*—The author points out a fallacy which may arise in the application of Newton's Theorem about conics, and gives a new geometrical proof of the theorem.

C. N. S.

Calcutta Mathematical Society:

November 29, 1936.—R. C. BOSE : *Theory of Skew Rectangular Pentagons in Hyperbolic Space. Part II.* M. DE. DUFFAHEL (STAMBOUL) : *Sur l'Equation aux derivees partielles qui se presente dans la theorie de la propagation de l'Electricite.* M. DE. DUFFAHEL (STAMBOUL) : *Sur les couples de Fonctions uniformes d'une variable.* B. B. SEN : *Note on the Transverse Vibration of Freely Supported Plates under the Action of Moving Loads and Variable Forces.* R. S. VARMA : *An Infinite Integral Involving Bessel Function and Parabolic Cylinder Function.* N. RAMA RAO AND BASAVA RAJU : *An Extension of Wilson's Theorem.* S. P. SLONGUINOFF (PERM, U. S. S. R.) : *Equation de Laplace dans l'espace a'deuse dimensions.* OLGA TAUSSKY (CAMBRIDGE): *Rings with Non-Commutative Addition.* S. GHOSH : *On the Solution of Laplace's Equation Suitable for Problems Relating to Two Spheres Touching each other.* S. GHOSH : *Stress Distribution in a Heavy Circular Disc held with its Plane Vertical by a Peg at the Centre.*

Indian Chemical Society:

August 1936.—S. S. BHATNAGAR, A. N. KAPUR AND P. L. KAPUR : *A Magnetic Study of Colour Changes in Cobalt Chloride. Part II.* PRIYADARANJAN RAY AND AMALENDRA NARAYAN GHOSH : *Complex Metal-ammonium Selenites and Selenito-metal-ammines.* C. C. PALIT AND N. R. DHAR : *Oxidation of Glucose in Presence of Insulin Glutathione and other Substances and the Probable Mechanism of Biological Oxidations.* S. C. DE AND P. C. RAKSHIT: *Synthesis in the Pyrazolone Series. Part IV.—Action of Aminoguanidines on β-Ketonic Esters and β-Diketones.* MATA PRASAD, M. P. LAKHANI AND JAGDISH SHANKAR : *An X-Ray Investigation of the Crystals of* p-*Nitrodiphenyl.* DINES CHANDRA SEN : *Studies in the Camphor Series. Part III. Tautomeric Behaviour of Thiocamphor and the Activity of its Sodium Derivatives.* M. Q. DOJA : *The Quaternary Ammonium Iodides of Dimethyl-*p-*toluidine.* RADHA RAMAN AGARWAL : *Chemical Examination of* Cuscuta reflexa Roxb. *Part IV.—Isolation of a New Yellow Flavone Colouring Matter from the Seeds.* NRIPENDRA NATH CHATTERJEE : *Spiro-compounds. Part I.—A New Route to Spiro-compounds. Synthesis of* Cyclo*hexane-spiro-*cyclo-*pentan...* M. Q. DOJA AND A. MOKEET : *Preparation of* p-*Diethylamino-benzaldehyde.* M. B. RANE, K. KONDAIAH, AND M. K. RATNAM : *Removal of Antimony from its Solutions by Nitric Acid.* S. D. SUNAWALA : *A Note on the Estimation of Formic Acid in Commercial Acetate of Lime. Review.*

Society of Biological Chemists, India:

Oct. and Nov. 1936.—A. KRISHNAMURTY: *Some Aspects of Malting.* B. A. SUNDARA IYENGAR: *Iron Mobilization and Plant Growth in Water-logged Soils.* PROF. C. R. NARAYAN RAO: *Is Man Part of the Animal World?* K. RAMI REDDI: *Biochemistry of Sonti Fermentation.* K. VENKATA GIRI: *Rôle of Phosphatases in Plants.* N. N. DASTUR AND K. V. GIRI: In vitro *Digestion of Fats.* V. K. BADAMI: *Influence of X-Rays on Plants.* K. V. GIRI AND P. N. BHARGAVA: *New Methods for the Detection of Adulteration in Food-stuffs.* A. Sreenivasan: *Influence of par-boiling on Quality of Rice.*

Indian Botanical Society:

October, 1936.—M. A. GINAI: *Further Contribution to Our Knowledge of Indian Coprophilous Fungi.* J. C. BANERJI: *Studies on the Myxophyceæ of Lower Bengal. I.—Preliminary Observations on the Group in Relation to Salient Ecological Factors and Systematic Enumeration of a Few Chroococcaceæ.* R. H. DASTUR AND D. E. WADIA: *A Study of Some Physico-Chemical Changes in Leaf Movements.* M. O. P. IYENGAR: Characiosiphon, *a new member of the Chlorophyceæ.—Preliminary Note.* B. SAHNI: *Wegener's Theory of Continental Drift in the Light of Palæobotanical Evidence.*

December, 1936.—V. S. RAO: *Studies on Capparidaceæ II.—The Embryology of* Gynandropsis Pentaphylla. R. K. SAKSENA: *Structure of the Nucleus in the Genus Pythium.* A. R. RAO: *A New Form of Botrydium from Lucknow.*

Meteorological Office Colloquium, Poona:

September 15, 1936.—MR. M. K. PARANJPYE: *'The Dust-Free or Dark Layer in Relation to Convection near Hot Surfaces.'*

October 10, 1936.—DR. S. CHANDRASEKHR (Fellow of the Trinity College, Cambridge, and Associate Research Professor of the Chicago University), "Luminosity of Gaseous Nebulæ":—After describing the characteristic features of gaseous nebulæ, Dr. Chandrasekhar discussed the physics of the luminosity of gaseous nebulæ. The luminosity of these bodies is now known to be derived from the radiant energy received by them from an adjacent star. The primary process is the ionization of the gaseous matter of the nebulæ—mostly hydrogen and helium. The subsequent return of the electron to the ionized atom causes the emission of the Lyman lines and of the He I and He II lines. These, in their turn, cause secondary emission of lines from atoms of the same kind and also from certain other atoms. For example, a few O III and N III lines are selectively excited by certain chance coincidences of He II, O III and N III lines. Another important mechanism of emission is the following: In the primary process of ionization, electrons are ejected from hydrogen and helium with energies equal to the difference between the energy of the incident quantum and the energy equivalent of the ionization potential of the atom. These electrons have comparatively low potential energies and their impact on atoms like O III and N III is responsible for raising them to metastable states and subsequent emission of low potential forbidden lines.

October 27, 1936.—DR. S. R. SAVUR.—"An improvement of the existing forecasting formulæ."

October 30, 1936.—DR. K. DAS described the Cosmic Ray apparatus used by Dr. Victor Neher (of the Californian Institute of Technology) at Madras where he let off a number of these instruments with balloons during October 1936, assisted by Dr. Das. With the help of an instrument which had kindly been sent by Dr. Neher on loan, he explained the mechanism of its working.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

University of Allahabad:

Mr. S. P. Naithani, Lecturer, B grade, Botany Department, returned from abroad after taking his PH.D. degree from the London University.

The Right Hon'ble Sir Tej Bahadur Sapru has donated a sum of Rs. 900 a year for the award of scholarships to poor students in the manner decided by the Vice-Chancellor. A similar donation of Rs. 500 from Professor Amaranatha Jha, Dean of the Faculty of Arts, Allahabad University, has been placed at the Vice-Chancellor's disposal for any non-recurring expenditure which may be considered desirable in the interests of the University. Messrs. H. K. Ghosh, Beni Madho and I. D. Varshney have offered scholarships for the B.COM. students of the University from this session.

The Ordinances for the degrees of D.SC. and D.LITT. have been thoroughly revised and a new D.PHIL. degree has been instituted under the Faculties of Arts and Science.

Messrs. R. N. Kaul and M. U. Ahmad, Lecturers in the Philosophy Department, have been appointed delegates to the Philosophical Congress which will be held at Delhi in December 1936.

Aligarh Muslim University:

Mr. Mohd. Afzal Husain Qadri, M.SC. (Alig.), has been awarded the degree of Doctor of Philosophy, in Zoology, of the Aligarh Muslim University. He submitted the following four papers bearing on the work done under the guidance of Dr. M. B. Mirza, Director, Zoological Laboratories.

(1) "Studies on the Mallophaga of North-Indian Birds." (*Zeit. f. Parasit.*, 1935, 8, Ht. 2).
(2) "Studies on the Mouth Parts of Mallophaga infesting North-Indian Birds." (*Proc. Ind. Acad. Sci.*, 1935, 3, No. 5).
(3) "Some New Mallophaga from North-Indian Birds." (*Zeit. f. Parasit.*, 1936, 8, Ht. 6).
(4) "The Male Genetalia of Mallophaga Infesting North-Indian Birds." (*Proc. Ind. Acad. Sci.* (in press).

Lucknow University:

The following Science Lectures have been arranged for the Winter Session (1936–37). The lectures will be held at 6-30 P.M. in the halls indicated.

*Dec. 4 and 5 (Chemistry Theatre).—
"The mechanism of chemical reactions." By **Dr. A. C. Chatterji.**

*Dec. 13 (Biology Theatre).—
"Recent geological changes in Northern India and their effect upon the drainage of the Indo-Gangetic basin." By Mr. D. N. Wadia.
*Jan. 8 and 9 (Chemistry Theatre).—
"Electrolysis of solutions." By Dr. S. N. Shukla.
Jan. 13, 14 and 15 (Biology Theatre).—
"The elements of the modern theory of aggregates." By Dr. A. N. Singh.
*Jan. 16 and 17 (Biology Theatre).—
"Competition in the plant world." By Dr. S. C. Verma.
*Jan. 22 and 23 (Chemistry Theatre).—
"The relation between physical properties and chemical constitution." By Mr. M. R. Nayar.
*Jan. 28 and 29 (Biology Theatre).—
"Mitogenetic rays." By Dr. S. N. Das Gupta.
*Jan. 30 (Biology Theatre).—
"Earth movements, vertical and horizontal." By Dr. B. Sahni.
*Feb. 8 and 9 (Biology Theatrre).—
1. "Helminthology and Agriculture." 2. "Helminthiasis in domestic animals." By Dr. G. S. Thapar.
(*These lectures will be illustrated.)

University of Madras:

Mr. Hadi Hasan of the Aligarh Muslim University delivered, under the auspices of the University, a lecture on "Arab Additions to Greek Learning" at the Government Muhammadan College, Madras, on the 10th October 1936.

A special meeting of the Senate was held on the 30th October 1936 to award the following titles and diplomas:—

Oriental Titles:—		
1. Siromani	.. .. ..	62
2. Vidvan	.. .. ..	130
3. Afzal-ul-Ulama	.. ..	9
4. Munshi-i-Fazil	.. ..	11
Diploma in Midwifery	.. ..	5
,, Economics	.. ..	3
,, Modern European Languages		8
,, Geography	.. ..	7
,, Indian Music	.. ..	9

The ordinary meeting of the Senate was also held on the 30th and 31st October 1936.

University of Mysore.

Convocation.—The 19th Annual Convocation for conferring degrees was held in Mysore on the 29th October 1936, His Highness the Pro-Chancellor presiding. Dr. E. P. Metcalfe, D.Sc. F. Inst.P., Vice-Chancellor, delivered the Convocation address.

289 candidates were presented for degrees in person and 26 candidates were admitted to degrees *in absentia*.

Meeting of the Senate.—A special meeting of the Senate was held on the 30th October 1936, for the election of three members of the University Council by and from the Senate, at which the following were elected:—

1. Mr. M. Sultan Mohiyuddin, M.A., LL.B., M.Ed., Deputy Director of Public Instruction in Mysore, Bangalore.
2. Mr. D. V. Gundappa, Proprietor, Karnataka Publishing House, Bangalore City.
3. Mr. Mirle N. Lakshminaranappa, B.A., LL.B., Advocate, Bangalore City.

Faculties.—Mr. E. K. Ramaswami, B.Sc., A.C.G.I., M.A.S.M.E., M.I.E., Professor of Mechanical Engineering, College of Engineering, Bangalore, was elected Dean of the Faculty of Engineering and Technology.

Extension Lectures.—The following extension lectures were delivered:

1. Mr. B. M. Srikantia, M.A., B.L., Professor of English, Central College, Bangalore, on "Life and Teaching of Basavanna" at Davanagere and on "Shakespeare's Historical Plays" at Chitaldrug, both in Kannada.

2. Mr. O. C. Gangoly of Calcutta, on (*a*) "History of Indian Painting," (*b*) "What is Art," at Bangalore and Mysore, in English.

L.M.P. Examinations.—The several L.M.P. Diploma Examinations for the year 1936 were held on the 1st and 2nd October with the following results:—

	No. examined	No. passed
First Examination ..	10	5
Second Examination ..	34	20
Third Examination	41	24
Final Examination ..	47	19

Meeting of the Senate.—The Ordinary Meeting of the Senate for the year was held on the 26th November 1936. Among the propositions that were passed, mention may be made of the following:—

(1) Addition of Hindi to the list of subjects for which Boards of Studies and Boards of Examiners have to be appointed. (2) Establishment of a University Training Corps. (3) Provision of a sum of Rs. 10,000 in the Budget for the publication of short books in Kannada on subjects of modern scientific interest. (4) Arrangement for securing consideration of the cases of graduates and under-graduates of the University in connection with appointment to vacancies occurring in the Postal and Telegraphic Departments within the Mysore State.

Extension Lectures.—The following Extension Lectures were delivered:—

(i) Mr. K. V. Puttappa, M.A., "Tragic Karṇa of Kumāravyāsa" in Kannada, at Tumkur, Madhugiri and Davangere. (ii) Rev. J. B. Freeman, M.A., L.T., Ph.D., C.D., "The Time Concept" in English, at Mysore. (iii) Mr. H. K. Ramiengar, M.A., "Village or Rural Industries," in Kannada, at Arsikere and Chickballapur. (iv) Mr. K. Sundaresan, L.M. & S., "Nutrition" in Kannada at Mysore and Bangalore. (v) Dr. K. N. Venkatasubba Sastri, M.A., Ph.D., F.R.Hist.S., "The History of Mysore Administration" in Kannada at Bangalore.

ERRATUM.

Vol. V, November 1936, page 244, *add* at the end of 2nd column.—

[1] *Am. Chem. Abs.*, 1922, **16**, 2323.
[2] *J. Am. Chem. Soc.*, 1931, **53**, 1106.
[3] *Cf.* Haworth and Perkin, *J.C.S.*, 1898, **73**, 330.
[4] *Cf.* Guha, Presidential Address, Chemistry Section, *Proc. Indian Sci. Cong.*, 1936, p. 115; Linstead, *Ann. Rep.*, 1935, **32**, 315 footnote.

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CURRENT SCIENCE

Vol. V] January 1937 [No. 7

The Indian Institute of Science—I.

We have read the report of the Second Quinquennial Reviewing Committee on the working of the Indian Institute of Science, and we congratulate the members on the remarkable celerity with which they have accomplished their task. We agree with the statement that the circumstances, under which the Committee assembled for commencing their labours, were not propitious, and the atmosphere of the Institute was impregnated with passion and prejudice arising from a clash of ideals. It is almost superhuman to escape being influenced by the prevailing public feeling, and we consider that the ardent observations expressed by the Committee in certain sections of the report can be traced to such influence.

It will be remembered that the practice of appointing periodical committees for reviewing the work of the Institute owes its origin to the recommendation of the Pope Committee which set forth this purpose in the following terms :

"The progress of a young institution of a character entirely new to India calls for the continual interest of those responsible for its development, not necessarily for purposes of criticism, but rather in order to determine in what ways its usefulness to the community may be extended."

We have now before us the reports of the three Committees, which after a careful and critical examination of the original intention of the Founder have provided us with comprehensive criticisms of the working of the Institute and with equally comprehensive recommendations for its improvement. The Committees differ regarding the interpretation of the aims and objects outlined in the scheme for the administration of the Institute and accordingly their recommendations diverge. It seems to us that the period of five years prescribed for the appointment of the Reviewing Committees is too short a term for the Institute to produce appreciable results, based on the recommendations of their predecessors, and frequently the authorities of the Institute

are bewildered by the conflicting reports and recommendations coming in quick succession, and reducing this great organisation to a state of perpetual transition. If the reports of all these three Committees are carefully perused, one cannot fail to discover that each of them has honestly endeavoured to pull the Institute inside out, and then laboriously to reconstruct a fresh model on the personal predilections of the members. In none of these reports could we discover an account of how far the recommendations of the previous Committee have been adopted by the Institute and with what results, but on the other hand the Committees have proceeded to their task as if they were the first body investigating into the working of the Institute. What is most surprising is that neither the Government of India, nor the Council of the Institute are embarrassed by the periodical revision of the aims and objects of the Founder, and by the multitude of conflicting recommendations for their speedier and better achievement.

In view of the far-reaching importance of the recommendations made by the Irvine Committee, which in certain respects appear to us impractical, we are definitely of opinion that the Institute should have reasonably long period of time to give them a fair and honest trial, without being encumbered by a further instalment of fresh recommendations by another Quinquennial Reviewing Committee. If in writing their report the Irvine Committee had reviewed the progress of scientific investigations in the official and non-official centres of research, as was done by the Pope Committee, we are convinced that their proposals of reorganisation would have assumed a different complexion. The want of this necessary background,—whose importance in the enquiry of the character such as the Committee had undertaken to investigate, few will be disposed to dispute, —has invested their suggested arrangements with an air of unreality. It is pointed out in more than one section of the report that the Institute should co-ordinate with other centres of research, both in the theoretical and applied branches of science, and the general reader of this document can obtain no information regarding the state of development reached by these institutions, without which he may presumably form no conception of the nature and extent to which any co-operation can profitably be established.

Dealing with the aims and objects of the Indian Institute of Science, a subject which has been critically and carefully examined by two previous Committees which had formulated the policy in clear and unambiguous language, the Irvine Committee report that

> " it is more than ever necessary to secure that the policy pursued is consistent with the wishes of the Founder and of the contributing bodies,"

and proceed to observe that

> " the province and purpose of the Institute must be defined in more precise terms than at present, and that such a definition should be adopted officially by the Council of the Institute and the Government of India. Only in this way can the aims and objects of the Institute be placed beyond individual and fluctuating interpretations; in the absence of such definition, no continuous policy can be developed."

If these sentences are intended to imply that the Institute has been working for the past twenty-five years and more without any specific aim and without ambition to achieve any definite object and without regard to the intentions of the Great Benefactor, we are afraid that the Irvine Committee will find neither the Council nor the Government sharing their sentiment. Reviewing the activities of the Institute for over twenty-five years,* Alchymist indicated their underlying policy in these terms :

> " Higher authorities concerned in establishing the Institute were very definite on this point, however, as appears from a resolution by the Government of India in this matter dated 27th May 1909. During the discussion then prevailing Government were of opinion that the idea of combining in one Institution and entrusting to a single staff of professors both the teaching of science and the experimental development of new industries, was open to the obvious criticism that these two objects were in no way connected together." Moreover the two educational experts (Professor Masson and Principal Clibborn) finally deputed to frame a scheme recommended, " that the Institute should be devoted to experimental science, and should aim at training students in experimental methods, carrying on original research and discharging the functions of an accepted authority and referee on all scientific problems within its own domain.
>
> " Finally the Vesting order founds 'an Institute of research in India' and the attached scheme of administration inculcates 'the promotion of original investigations in all branches of knowledge and their utilisation for the benefit of India' without specific mention of industrial activities."

In reviewing this official policy which continued to be the basis of the entire range of

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* *Curr. Sci.*, Octr. 1932, p. 91.

activities of the Institute till 1921, the Pope Committee observed that

"the Founder of the Institute, the late Mr. J. N. Tata, desired to establish an Institute of Research; so far as our information goes he introduced no limiting clauses in connection with his benefaction, but it is probably beyond dispute that he desired to build and endow an institution which would provide Indian students with such facilities for work and training as would enable India to compete on equal terms with other countries as a producer of new knowledge and that he wished his Institute to aid Indian students to serve India in Science and Technology. It cannot be doubted that, under the conditions briefly stated above, the objects which the Founder had in mind will be best served by the provision of preliminary training in scientific methods and knowledge, supplementary to more Elementary Scientific education, for the purpose of preparing selected individuals for careers based upon original work in either pure science or technology."

In further examining the aims and objects of the Institute, the Sewell Committee wrote that

"while agreeing with the resolution of the Pope Committee that 'it is undesirable that the activities of the Institute, in connection with teaching and research, should be confined to matters which bear on the application of science to industry,' we are of opinion that in the future more attention should be paid to those lines of research that have or may have a direct bearing on the existing industries of India or that may be expected to open up fresh industries at present undeveloped in this country."

The Irvine Committee observe that

"neither of these reports challenges the view that the Founder desired to encourage industry and this remains the primary function of the Institute."

"In coming to the above conclusion it is far from our intention to deprecate academic research. We are fully alive to the advantages and the cultural and material benefits which accrue from fundamental scientific work; equally we recognise that there is no conflict between pure and applied research which can be and ought to be, prosecuted side by side to their mutual advantage. We are chiefly concerned with the problem as to which of these complementary activities should carry the greater emphasis and we hold strongly the opinion that, in accordance with the wishes of the Founder, this emphasis should be laid on the application of scientific research to industry."

These views are obviously opposed to the resolution of the Government of India and to the opinions of the educational authorities deputed to frame a working scheme thereunder. The Pope and Sewell Committees did not exalt industrial research to the position of pre-eminence, subordinating academical enquiries. The fluctuations in the interpretation of the fundamental intention of the Founder were not the making of individuals, but are entirely due to the personal predilections of the Committees. The Irvine Committee were led to formulate their views expressed in their amendment to Clause 3 in the Regulations chiefly because in their opinion the phrase "the benefit of India" occurring in the Scheme of Administration, implies "that the activities of the Institute should be devoted primarily to securing for India the material benefits expected to follow from the close association of the scientific research with the industries of the country". This is only partly true, for the scheme of administration comprehends something more fundamental than material prosperity, for it specifies,

"That the object of the Institute shall be to establish Chairs and Lectureships in Science and Arts, especially with a view to the promotion of original investigation in all branches of knowledge and their utilisation for the benefit of India."

If, however, the Irvine Committee had considered in their report the progress of work achieved in other institutions specially equipped and organised by the Provincial and Central Governments to investigate material and cognate problems, they would have expressed their views regarding the aims and objects of the Institute in more restrained terms. Besides in formulating the scientific policy of a Foundation which has carried on its activities for over 25 years on the basis of the resolution of the Government of India at the time of its inception, the Committee should have taken into consideration the geographical position of the Institute, its existing equipment and organisation, the training, knowledge and capacity of the members of the staff to give practical effect to the new proposal.

We shall now proceed briefly to deal with some of the specific recommendations of the Committee. In their suggestions respecting the correlation of research work conducted in the Institute with the industrial needs of India, they observe

"That it is essential to relieve the staff of the sole responsibility for finding industrial problems for investigation. These problems should be submitted to the Institute by some responsible body capable of collecting proposals from India as a whole and of sifting them so as to exclude merely routine enquiries and suggestions which are too unwieldy to be handled by the comparatively small number of workers available at Bangalore. The initiation of problems might well be undertaken by such bodies as (1) The Industrial Intelligence and Research Bureau,

(2) The Imperial Council of Agricultural Research and (3) Departments of Industries."

Writing on the claims of External Bodies on services of staff, the Pope Committee wrote as follows:

"It will be at once obvious that if outside bodies or persons including governments and administrations, exercise any claim upon the professional services of the professorial staff of the Institute, grave difficulties will immediately arise connected with what may be termed the regular work of the staff, namely, the training of students and the prosecution and direction of research work. In a country like India, which is doubtless on the eve of great developments in its natural resources and which does not as yet command in its industries the services of technologists in all the branches of scientific industry which will be established in the near future, it is conceivable that the interest of the country may be best served by utilising for specific investigations the services of one or other members of the staff of the Institute. We are, however, of opinion that unless imperative necessity demands, it is undesirable that the members of the staff of the Institute should be drafted way to deal with outside problems which may present themselves to Indian governments and administrations."

It is obvious that a research institution of the magnitude and importance of the Indian Institute of Science should be permitted to enjoy complete scientific autonomy within its own domain, and any attempt to restrict its freedom may result in the defeat of the very object which the Irvine Committee are so genuinely eager to promote. During its fairly long history, the Institute has established certain traditions, and reform in the desired direction must proceed on lines of least resistance. The transformation of the Institute into a centre of industrial research, so as to secure the material welfare of India, can take place, provided it is re-equipped and re-staffed and the external agents continue to supply a steady stream of problems.

In their recommendations to make applied research the first and most responsible duty of the Institute, the Irvine Committee suggest that "the active prosecution of applied research should be regarded as a duty, willingly undertaken with the certain knowledge that the more energetically this duty is fulfilled, the less scientific prominence becomes attached to the workers themselves. Few publications are likely to result from such research work, but this need not be deplored if in the end the Institute is made to play the part for which it was created." Assuming that the Institute was brought into being solely for the purpose of promoting industrial research, it is conceivable how far the ideal of self-efacement advocated by the Committee will attract scientists of eminence to the work outlined in the scheme. Most scientific men are, generally sreaking, regardless of the worldly goods, and as a compensation they naturally look for the recognition of their work by the learned societies, whose distinctions are, however, awarded absolutely on the basis of published records. Suppose there is a fall in the number of papers, will the professors of the Institute have the assurance that they are immune to the criticisms of the next reviewing committee for such paucity.

Commenting on the financial position of the Institute, the Committee observe that "income no longer balances the normal recurring expenditure, and it has become necessary to draw on the accumulated reserves in order to meet the annual deficit." In Part II of the report the figures for income and expenditure for seven years are given in a tabular form, and we calculate that the total revenue for this period amounted to Rs. 40,03,678 and the recurring expenditure for this period amounted to Rs. 37,95,735. The income did balance "the normal recurring expenditure". During this period, however, the Institute spent Rs. 5,18,549 under the head "non-recurring expenditure", which manifestly utilised in the extension of existing buildings, or the addition of new ones, or in the purchase of costly apparatus, must be of permanent value as additional investment. If the accumulated reserves have been partly used up for this purpose, the authorities of the Institute had the support of the Sewell Committees which wrote that "the opening balance in each case includes funds held in suspense for retiring allowances and depreciation; the portion of the opening balance now available for ordinary expenditure is Rs. 6·55 lakhs. Although in some undertakings such figures would indicate a most satisfactory state of affairs we view with some apprehension the accumulation of funds to this extent in an institution which is purely educational. It is open to question whether this accumulation of funds is justified when the Institute is in receipt of substantial grants from some of the Provincial and State Governments."

We propose to deal with the remaining sections of the report in our next issue.

Geographical Distribution of Indian Freshwater Fishes and Its Bearing on the Probable Land Connections between India and the Adjacent Countries.*

By Sunder Lal Hora, D.SC., F.R.S.E., F.N.I.
(*Assistant Superintendent, Zoological Survey of India, Calcutta.*)

THE relationships and the geographical distribution of the freshwater fishes of India were discussed by two of the leading ichthyologists, Day[3,4]† and Günther[7], of the last century. The former advocated Malayan affinities for the Indian fauna, while the latter, though admitting the migration of several Oriental freshwater fishes to Africa, laid special stress on the African affinities of this fauna. Beyond some casual references[1,2] very little work has since been done on this aspect of the Indian freshwater fishes, and in view of the advances that have been made in our knowledge of the paleogeography and systematics of fishes it seems opportune to review the whole subject in the light of recently discovered facts.

A freshwater fish lives entirely in freshwater, both in the young and adult stages, and never descends to the sea. The above definition excludes all anadromous fishes which are essentially marine but ascend freshwaters for breeding, and the catadromous fishes which are essentially freshwater forms but descend into the sea for similar purposes. As the freshwater fishes are generally restricted to the water courses in which they live, they form a very important group for the elucidation of the paleohydrographical relationships of adjacent lands. Watersheds in the case of these fishes form effective barriers so long as their positions remain unchanged; the process of river-capture, however, may facilitate their migration in one direction but not in the other. There is an unfortunate impression, mainly among geologists, that in the case of fishes dispersal may be effected through the agency of birds, chiefly aquatic species, which may carry the eggs attached to their feet from one watershed to another. Those, who have paid particular attention to this matter, however, are definitely of the opinion that such a mode of dispersal of freshwater fishes is normally highly improbable, even though there may be records of such fortuitous dispersal in practically all groups of animals including freshwater fishes.

In connection with my work on the Siluroid fishes of India for a revised edition of "Fishes" in the *Fauna of British India* series, I have been greatly struck by the close similarity of the Indian forms to those found towards the east in Indo-China, Siam, and the Malay Archipelago. As a result of a detailed study of the genera and species inhabiting these regions I am definitely of the opinion that the freshwater fish fauna of India in the main originated in South-eastern Asia, most probably in Indo-China, and spread westwards by successive waves of migration to India and later to Africa while the two masses of land were connected with each other. Gregory's researches[5,6] on the evolution of the mountain and river systems of South-eastern Asia have shown that in this region there were extensive river captures—the rivers on the west beheading the rivers on the east; these changes made possible the migrations of aquatic animals from the east to the west but not in the reverse direction. Gregory's researches have further shown that all the rivers of Eastern Tibet drained into the Gulf of Siam or the South China Sea before the present river systems became established, and this bears out Pelseneer's view.[12,13] The freshwater fauna of Eastern Asia at least may have originated along the coasts of Indo-China, when the ocean water in this area was greatly diluted by the drainage into it of several river systems.

Professor Gregory's views about the capture of the eastern rivers by the western rivers are, however, not accepted by all geologists, for there is a general belief that the Brahmaputra and the Irrawaddy-Salween systems were separated in the Pre-Eocene period by the Tethys Sea and in the Post-Eocene days by the newly upheaved Himalayas, the

* Summary of the remarks made at the Hyderabad meeting of the Indian Science Congress during a joint discussion between the Sections of Geology, Botany and Zoology on Wegener's theory of Continental Drift with special reference to India and the adjacent countries, and published with permission of the Director, Zoological Survey of India.

† Numerals refer to the corresponding numbers in the list of references at the end of the article.

Patkoi Range and the Arakan Yomas. According to these views there could not be any migration of freshwater faunas by a system of river-captures, except perhaps during the transition periods, between the Indo-Chinese rivers and the Indian rivers. Further there is no geological evidence for the Indian rivers having originated in Burma. Some of the peculiarities in the distribution of Indian freshwater fishes may be explained on the supposed existence of the Siwalik or the Indo-Brahm River,[11,14,18] but a considerable mass of evidence bearing on the close relationship and distribution of the fishes of South-eastern Asia demands for its explanation a hypothesis similar to that worked out by Gregory. This mass of evidence is so striking and convincing that it may be worth-while for the geologists to re-examine their data regarding the Cretaceous-Tertiary land connections between India and the Far East.

Mori[10] has recently stressed the Oriental affinities of the fish-fauna of the Upper Yangtse-Kiang which comprises an abundance of the Siluroidea, the Homalopteridæ, the Ophicephalidæ and a large number of Indian genera of the Cyprinidæ. These results fully support Gregory's work according to which the Upper Yangtse-Kiang at first drained into the Red River but later turned northeastwards across Central China to the East China Sea. Only such a course of events could account for the presence of Oriental genera in the Upper Yangtse-Kiang and the Palæarctic genera in its middle and lower portions. According to Mori's researches the Nan Shan Mountain Range divides China into the northern Palæarctic subregion and the southern Oriental subregion.

As a comprehensive example of the east to west migration of the aquatic fauna, one may consider the evolution and distribution of the family Schilbeidæ* which is represented both in the Oriental and the Ethiopian regions by a number of genera. Of the 19 or 20 genera of the family that can be recognised at the present day there is not one that is common to the two regions. If it be conceded that the ancestors of the Schilbeidæ were devoid of barbels and teeth in the jaws, it naturally follows that the African genera, usually with eight barbels and a well-developed dentition, represent a fairly specialised and more highly evolved branch of the family; African genera such as *Ansorgia* Boulenger, with only one pair of mandibular barbels, and *Siluranodon* Bleeker, with no teeth in the jaws, are retrogressive forms as compared with the primitive genera found in the Far East. I believe that *Pangasianodon* Chevey, represents the least specialised form of the family; this genus is found in Indo-China and is characterised by the possession of two minute maxillary barbels, a large air-bladder and no teeth. *Silonia* Swainson, of the Indian waters, also possesses two minute barbels, but owing to its highly predaceous habits, it has developed large caniniform teeth both in the jaws and on the palate. Due to the reduction of its body cavity by the greater development of the caudal region and the lateral compression of the body the air-bladder is greatly reduced. In Peninsular India some less specialised, *Silonia*-like fishes became further modified and developed two additional mandibular barbels; they possess caniniform teeth and a long anal fin but the air-bladder is not so greatly reduced as in *Silonia*. For this new type I have proposed the name *Silonopangasius*.† So far as can be judged at present this line of specialisation only extended as far as the extreme west of Peninsular India.

Pangasianodon-like ancestors also gave rise to forms like *Helicophagus* Bleeker and *Pangasius* Cuvier and Valenciennes; the latter is found from Indo-China to India, while the former, in which the dentition is only partially developed, is found only in the Far East and is absent from Burma and India. Though there are several species of *Pangasius* in Indo-China, Siam and the Malay Archipelago, in Indian waters it is represented by a single, very highly specialised form. Here again the specialisation in form occurs as one proceeds from the east to the west.

In Siam and the Malay Archipelago *Helicophagus* gave rise to the genus *Laides* Jordan (= *Lais*, 6 barbels); possibly *Laides* evolved into *Pseudeutropius* Bleeker (8 barbels) in the Malay Archipelago; the latter genus is also found in India. Certain members of *Pangasius*, probably more specialised as regards dentition, gave rise in

* For a detailed treatment of the classification, distribution, ecology and evolution of the Schilbeidæ reference may be made to my paper, shortly to be published in the *Records of the Indian Museum*.

† Genotype: *Ageneiosus childreni* Sykes, 1841.

Siam to *Platytropius*,* a new genus with extensive patches of vomero-palatine teeth, and with a flattened head and air-bladder, and in India to *Proeutropiichthys*,† a new genus for species of *Pseudeutropius* with four patches of teeth on the palate. In the Indian waters *Pseudeutropius* gave rise to *Ailia* Gray and *Proeutropiichthys* to *Eutropiichthys* Bleeker, the latter genus is also known from Siam. Probably *Platytropius* gave rise to *Clupisoma* Swainson of the Indian Waters. From the primitive stock that gave rise to *Proeutropiichthys*, probably developed all the Schilbeid genera of Africa, at a stage when the mandibular barbels were considerably behind the tip of the lower jaw and were not situated in a straight line. So far no intermediate forms have been discovered between the Indian *Pseudeutropius* (*sensu lato*) and the African *Eutropius*. As the difference in the two forms consists mainly in the position of the mandibular barbels, no palæontological records will ever be able to bridge the gulf between the Indian and the African Schilbeidæ. There is, however, little doubt about the close genetic affinities of the Indian and the African genera of the Schilbeidæ.

According to Regan[16] "The distinctness of the African and the Indian Schilbeidæ makes it probable that this family was established in both regions in pre-tertiary times." The probable history of the dispersal of the Schilbeidæ as understood by me makes it clear that this family must have extended its range to Africa before the two continents became disconnected, probably during or after the Eocene.

The facts detailed above concerning the geographical distribution of the Schilbeidæ are opposed to the theory of permanence of oceans and continents, as they can only be explained by the existence of connected water courses, through either river-captures, commingling or otherwise, over a land connection between India and Africa. Whether this connection was in the form of a "land-bridge" between the two continents, or the two land-masses were merely juxtaposed at some remote period and later drifted apart, it is very difficult to decide. It seems clear, however, that even during the Eocene South India and Africa had land-connections which permitted a dispersal of the freshwater fishes from the former to the latter country. The abrupt change in the African and the Indian Schilbeidæ is certainly the result of some form of isolation since a fairly remote period, and before this occurred presumably the Indian forms were of the same type as those now found in Africa. The higher specialisation of the Indian genera can be accounted for by the fact that India was a centre of great disturbance during the Tertiary period owing to the earth-movements that gave rise to the Himalayas, whereas Tropical Africa with its large lakes provided a stable environment for its fauna and the specialisations of the Schilbeidæ of this region can definitely be correlated with life in comparatively calm and clear waters.

There is also a belief that the Ostariophysi, the class to which Catfishes and Carps belong, originated in the north and spread southward to different continents. This hypothesis would explain the occurrence of allied genera both in India and Africa without the aid of a land connection between the two countries. Regan[16] has already pointed out that this view "involves so many improbabilities as to be almost unbelievable." The mode of dispersal of the Schilbeidæ as detailed above is strongly opposed to the northern origin of the Ostariophysi and appears to be entirely in accord with the recent geological work on the river and mountain systems of South-eastern Asia.

While discussing the African element in the freshwater fauna of India Annandale[2] remarked: "Doubtless the three territories (*i.e.*, Africa, S. America and India) had then a very similar freshwater fauna, but there is some evidence that Africa was its centre of distribution." Unfortunately he made no reference to this evidence, and in view of what is stated above it seems almost impossible to believe that the freshwater fauna of India was at any stage, at least during the Tertiaries, invaded by that of Africa.

Prashad[15] from his study of the recent and fossil Viviparidæ (Mollusca: Gastropoda) came to the conclusion that "Peninsular India forms the central zone whence the Viviparids of Asia and Africa are derived." At the present day, so far as freshwater fishes are concerned, Peninsular India contains many primitive forms, and thus

* Genotype: *Pseudeutropius siamensis* Sauvage, 1883.

† Genotype: *Eutropius macrophthalmus* Blyth, 1860.

superficially it may appear to be a centre of origin of the common Indo-African fauna, but the taxonomic and paleogeographical evidences adduced above show that the freshwater fish-fauna of Peninsular India was itself derived from that of South-eastern Asia.

The close relationship between certain highly peculiar genera of Indo-China and India, such as *Carpiocatla* Boulenger, and *Catla* Cuvier and Valenciennes; *Parapseudecheneis* Hora and *Pseudecheneis* Blyth, *Gyrinocheilus* Vaillant and *Psilorhynchus* McClelland; etc., etc., and the distribution of *Silurus* Linnæus and the Homalopteridæ also prove conclusively that there has been an east to west migration of the freshwater fauna in South-eastern Asia. The older genera, such as *Mastacembelus* Cuvier and Valenciennes, *Notopterus* Lacépède, *Labeo* Cuvier, *Barbus* Cuvier and Valenciennes, *Barilius* Hamilton, *Heterobranchus* Geoffery, *Clarias* Gronovius, etc., which are common to Africa and the Oriental region, probably spread from India to Africa at the time of the Cretaceous buckling which, according to Gregory[6] (p. 134), "produced a series of continental valleys trending east and west fragments of which still survive in Africa in the basins of the Zambezi, the middle Congo, and the northern section of the Niger." The physiography of India, however, underwent considerable changes during the Tertiary period.

In elucidating the geographical distribution of animals, great significance is generally attached to the occurrence of the same genus or species on two distinct land masses. According to the more or less accepted views on evolution a species or a genus can exist unchanged through millions of years only if there had been no change in its *milieu* throughout this period. Even gradual changes in the environment of an animal induce fine adjustments on the part of the organism.[8] Any small changes of organisation are utilised by taxonomists in their system of classification. As the science of taxonomy progresses, animal structure is bound to receive closer and closer scrutiny, with the result that a genus occurring over a wide area will be found to consist of several well-defined groups. Isolation and segregation are two very important factors in the production of new forms,[1,7] and it seems highly desirable, therefore, to pay more attention to the interrelationship of the seemingly divergent genera of different land-masses rather than to look for precisely identical animals in their fauna. The converse is also true. In the case of similar forms occurring in two widely separated places convergent evolution should not be invoked unless no other explanation seems possible. In the two sets of genera mentioned above the truth of these remarks is clearly brought out.

So far I have referred only to the Far Eastern genera that are found in the Indian waters. There is, however, one genus *Etroplus* Cuvier and Valenciennes of Peninsular India and Ceylon which has its close allies only in Madagascar. Günther[7] accounted for its occurrence in India as follows: "*Etroplus* inhabits Southern and Western India and Ceylon, and has its nearest ally in a Madagasse Freshwater fish, *Pareutroplus*. Considering that other African Chromides [Cichlidæ] have acclimatised themselves at the present day in saline water, we think it more probable that *Etroplus* should have found its way to India through the ocean than over the connecting land area; where, besides, it does not occur." I am in agreement with Günther's supposition and believe that *Etroplus* came to India *via* the sea and, after becoming a freshwater form, probably along the Malabar Coast, it remained confined only to the south-western part of the Peninsula, as the rivers of this area probably never became connected with the Indus and the Ganges systems. Further, it seems probable that *Pareutroplus* Bleeker and *Eutroplus* are derived from a common Cichlid ancestoral form that wandered across from the east coast of Africa to Madagascar and South India where they became acclimatised to freshwater conditions independently.

It is generally believed that the land connection between India and Africa disappeared somewhere about the transition period between the Cretaceous and the Tertiary. It is during the obscure interval between the Cretaceous and the Tertiary that nearly all the modern types of bony fishes originated. Regarding the freshwater Catfishes (Siluroidea), to which the Schilbeidæ belong, there is no evidence that they are of any great antiquity; their first known appearance is indicated by some fossils in the Tertiary deposits of the Siwaliks and the highlands of Pedang in Sumatra, where remains of some of the living genera have been found. I have referred above

to the continuity of distribution of the Schilbeidæ from Indo-China to Africa, and the same is true of the Catfishes of the families Clariidæ and Bagridæ. The Clariidæ live in mud in marshy areas of both countries and have thus retained their primitive habits. On account of this we find that *Heterobranchus* and *Clarias*, the two oldest members of the family, are common to the two continents. Tropical Africa with its vast stretches of ancient lakes provided a more suitable *milieu* for these fishes, some of which took to a burrowing mode of life. Consequently they became eel-shaped and their accessory respiratory organs and the associated skeletal elements became degenerate. In India, on the other hand, the conditions were very unstable during the Tertiary period, with the result that the primitive genus *Heterobranchus*, of which fossil remains have been found in the Siwalik formations of the Lower Pliocene, disappeared altogether and only one highly specialised species of *Clarias*,[9] *C. batrachus* Linn., is now found throughout India, while two other less specialised forms, *C. brachysoma* Günther and *C. dayi* Hora, are confined to Ceylon and the Wynaad Hills respectively.

The Bagridæ, like the Schilbeidæ, became established on both the continents at an early date and after the severance of the connection between the two lands evolved independently so that at the present day there is no genus common to the two regions. However, a close parallelism exists between the forms inhabiting similar situations on the two continents. *En passant* it may also be remarked that most of the other Siluroid families of India and Africa are evolved from the Bagridæ.

A remarkable feature of the Schilbeidæ is that no member of the family is found in Ceylon, which may be due to the fact that Ceylon became separated from India at a stage earlier than the disappearance of the land connection between India and Africa. The absence of the Schilbeidæ from Ceylon may also be explained on the assumption that at some period the water courses changed in such a way that in spite of the land connection between India and Ceylon no migration from the north to the south could take place. It is thus seen that unlike the distribution of the land animals, where probably the climatic considerations are of the greatest importance, the aquatic animals are bound within their watersheds and in spite of land connections and favourable climatic conditions between two adjacent lands may not spread from one to the other if their water courses had no chance to become continuous at some period or another. The distribution of fishes, therefore, though extremely important in zoogeographical studies, has thus only a limited value in elucidating the extent of the former land and sea connections.

In this east to west migration of the fauna I have assumed throughout that India was connected with the Far East, at least from the late Cretaceous onwards. This connection was of a very different nature from what it is to-day, for in the early Tertiaries a considerable part of Northern India was under the sea. The Bay of Bengal is considered to be an ancient feature of the physiography of India, so that the old connection between India and the Far East probably stretched over the Peninsula through the coal-field areas of Bengal to the Assam Hills, North Burma and beyond. At certain periods the direct land connection between Assam and Burma was cut off by an arm of the sea, but still Assam remained connected with the Far East through Tibet and Southern China. The distribution of the Indian freshwater fishes affords ample evidence in support of these routes of migration.

I may also refer here to the remarkable similarities between the faunas of the Malay Archipelago, Malabar Zone of South India and Tropical Africa. To account for these anomalies of distribution several workers have been led to establish a southern continent including South America, but of which Madagascar did not form a part. In my opinion when the primitive forms were spreading from Indo-China to Africa they sent branches to the south in all areas over which they passed, and as these southern extremities were away from the main centre of disturbance (the Himalayas) and also somewhat out of the way of the succeeding waves of migration they continued to harbour primitive animals in, what one may say, these corner seats. The islands of the Malay Archipelago, such as Java, Sumatra, Borneo, etc., the Malabar Zone of India and West and South Africa to-day form the limits of the ancient waves of migration and consequently contain many primitive forms, which, owing to the

severance of land connections, could not spread any further. Of the genera I have referred to above, *Heterobranchus* of the Clariidæ shows a discontinuous distribution as it is found in Africa on the one hand and in Banka and Borneo on the other. There is no doubt that even in the Lower Pliocene period its range of distribution must have been more or less continuous, as fossils are known from the Siwalik formations of that period.

It seems highly probable that the southward migration of the Indo-Chinese fauna in the region of the Malay Archipelago must have followed the course of the Indo-Malayan Mountains and of the Malay Arc[5] by a series of river-captures. The strong similarity between the fauna of South India and that of the Malay Archipelago[5] is probably not due to the migrations of the forms *inter se* but to their common origin from an east to west migrating, primitive stock.

In the above discussion I have not taken into consideration the route of migration that now exists between North-western India, through Baluchistan, Persia, Mesopotamia, Palestine, etc., to Africa. This route is known as Jocobi's Arabian region of dispersal and does not seem to have played any important part in the interchange of the freshwater faunas from Africa to India. Some of the Indian forms, however, such as *Glyptothorax* Blyth, *Garra* Hamilton, etc., have undoubtedly spread westwards along this route. *Scaphiodon* Heckel appears to be the only form that may have spread from Persia, Baluchistan and Sind to the Western Ghats.

To sum up it may be stated that the evidence provided by the distribution of the freshwater fishes of India indicates an eastern origin of the fauna and its subsequent dispersal to the west. The close relationship between the Indian and the African freshwater fishes can only be explained on the assumption of a land connection between the two countries. The absence of the Schilbeidæ from Ceylon and their presence in Africa suggests that Ceylon may have become separated from India at a stage earlier than the severance of the land connection between Africa and India. The distribution of freshwater fishes shows that Peninsular India had a land connection with the Far East, at least from late Cretaceous onwards, and probably at no time during this interval it became an island. The similarity in the faunas of South and West Africa, South India and the Malay Archipelago are probably due to the fact that they received branches of the primitive stock when it was migrating from the east to the west along a northern and a considerably more disturbed part of the Oriental region. The above review of the subject clearly shows that there is no African element in the freshwater fish-fauna of India. The existing connection of Africa with North-western India is comparatively of a much more recent date and does not seem to have played any important part in the dispersal of the freshwater faunas.

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[1] Alcock, A., "A Descriptive Catalogue of the Indian Deep-Sea Fishes," 1899, pp. 3, 4 (Calcutta).

[2] Annandale, N., "The African Element in the Freshwater Fauna of British India," *Proc. IX^e Intern. Cong. Zool. Monaco.*, 1914, pp. 579–588.

[3] Day, F., "Geographical Distribution of Indian Freshwater Fishes. Part I. The Acanthopterygii, Spiny-rayed Teleostean Fishes; Part. II. The Siluridæ; Part. III. Conclusion," *Journ. Linn. Soc. London, Zool.*, 1876, **13,** 138–155; 338–353; *ibid.*, 1879, **14,** 534–579.

[4] Day, F., "Relationship of the Indian and African Freshwater Fish-Faunas," *Journ. Linn. Soc. London, Zool.*, 1885, **18,** 308–317.

[5] Gregory, J. W., and Gregory, C. J., "The Alps of Chinese Tibet and their Geographical Relations," *Geog. Journ.*, 1923, **61,** 153–179.

[6] Gregory, J. W., "The Evolution of the River System of South-Eastern Asia," *Scottish Geog. Mag.*, 1925, **41,** 129–141.

[7] Günther, A., "The Study of Fishes," 1880, pp. 220-233, Edingurgh.

[8] Hora, S. L., "Ecology, Bionomics and Evolution of the Torrential Fauna," *Phil. Trans. Roy. Soc. London*, 1930, **218,** 171–282.

[9] Hora, S. L., "Siluroid Fishes of India, Burma and Ceylon. VI. Fishes of the genus *Clarias* Gronovius," *Rec. Ind. Mus.*, 1936, **38,** 347–351.

[10] Mori, T., *Studies on the Geographical Distribution of Freshwater Fishes in Eastern Asia.* (Chosen: 1936.)

[11] Pascoe, E. H. "Early History of the Indus, Brahmaputra and Ganges, "*Quart. Journ. Geol. Soc.*, 1919, **75,** 136.

[12] Pelseneer, P., "L' Origine des animaux d' eau douce," *Bull. Acad. Roy. Belgique.* (Classe des Sciences), 1905, No. 12, p. 724.

[13] Pelseneer, P., "L' Origine des faunes d' eau douce," *Reme de mois, Paris*, 1928, **2,** 413–425.

[14] Pilgrim, G. E., "Suggestions Concerning the History of the Drainage of Northern India," *Journ. As. Soc. Bengal* (N. S.), 1919, **15,** 81.

[15] Prashad, B., "Recent and Fossil Viviparidæ. A Study in Distribution, Evolution and Paleography," *Mem. Ind. Mus.*, 1928, **8,** 246.

[16] Regan, C. T., "The Distribution of the Fishes of the Order Ostariophysi," *Bijdr. Dierkunde Amsterdam* (Max Weber Feest-Nummer), 1922, pp. 203-208.

[17] Regan, C. T., "Mendelism and Evolution," *Nature*, 1924, **113,** 569.

[18] Wadia, D. N., "The Tertiary Geosyncline of North West Punjab and the History of Quarternary Earthmovements and Drainage of Gangetic Trough," *Quart. Journ. Geol. Mining and Metallurgical Soc. India*, 1932, **4,** 69-9-6.

On the Food Factors of the So-called Mosquito-Destroying Fishes of Bengal.—*Panchax panchax, Barbus stigma, Esomus danricus and Trichogaster fasciatus.*

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I. Introduction.

THERE has been much talk in recent times about the importance of fish in the control of Anopheles larvæ and the malariousness of a place. Those who advocate the adoption of biological control measures by the introduction of fish derive their inspiration from the reported achievements of the '*millions*' in the West Indies and *Gambusia* in parts of America in the destruction of Anopheles larvæ. But in the present state of our knowledge it is hardly possible to estimate correctly the importance of fish as destroyers of Anopheles larvæ. Most of the authors based their observations on laboratory experiments. The real test of the effectiveness of fishes in controlling Anopheles larvæ should depend on the determination of what they actually feed in their normal habitat.

In India, different authors have suggested different lists of larvicidal fishes and as time passed more and more new fishes appeared in the lists (Table I). With a

TABLE I. *List of Larvicidal Fishes.*

Chaudhuri (1911)	Sewell & Chaudhuri (1912)	Fry (1912)	Wilson (1917)	Southwell (1920)	Chatterjee (1934?)
Haplochilus panchax	*H. panchax*	*Haplochilus panchax*	*Haplochilus*	*Haplochilus panchax*	*Panchax panchax*
	H. melastigma	*H. melastigma*		*H. melastigma*	*Haplochilus melastigma*
	H. lineolatus			*H. lineolatus*	
Barbus plutunio	*Barbus phutunio*	?	*Barbus*	*Barbus plutunio*	*Barbus*
	B. stigma			*B. stigma*	
	B. ticto	*Barbus ticto*		*B. ticto*	
	B. terio			*B. terio*	
Ambassis	*Ambassis ranga*	*Ambassis ranga*		*Ambassis ranga*	
	Ambassis nama	*A. nama*		*A. nama*	
Trichogaster	*Trichogaster fasciatus*	*Trichogaster*		*Trichogaster fasciatus*	*Trichogaster fasciatus*
Anabas scandens	*Anabas scandens*	*Anabas scandens*		*Anabas scandens*	*Anabas testudineus*
Badis badis	*Badis badis*			*Badis badis*	*Badis badis*
Clarias magur					*Clarias batrachus*
Saccobranchus fossilis					*Saccobranchus fossilis*
Notoptereus kapirat					*Notopterus*
Gobies					*Glossogobius guiris*
Nuria danrica	*Nuria danrica*			*Esomus*	*Esomus danricus*
Carps (fry)					*Carps (fry)*
	Lebias dispar				
			Chela		*Chela*
			Rasbora	*Rasbora daniconious*	*Rasbora daniconius*
			Barilius	*Barilius* spp.	
			Therapon		
			Polycanthus		
				Wallago attu	*Wallago attu*
				Danio rerio	
					Amblypharyngodon mola
					Ophiocephalus
					Mugil corsula
					Lates calcarifer (fries)

view to ascertain how far the indigenous small fishes of Bengal feed on the Anopheles larvæ, a systematic examination of the gut contents of the fish caught in their natural haunts was carried out. The water-collections from which the fishes had been collected were invariably breeding Anophelines. The observations were spread over a period of two years from October 1934 to September 1936.

II. Methods.

The fishes were collected from the various types of water-collections which are usually met with in the neighbourhood of Calcutta and were nearly always brought alive to the laboratory soon after capture. The fishes were dissected as far as possible on the day of catch ; in cases where it was not possible to do this, they were preserved in 5 per cent. formaline or in rectified spirit.* The abdomen of the fish was cut open from one side under a dissecting microscope and the mid-gut removed on a slide. The contents of the gut were then squeezed out from one end on to the slide and examined under the microscope.

III. Analysis of Stomach Contents.

Although the food materials in the gut of the fish were often in an advanced state of digestion sufficient clue could still be had in the cuticular or ligneous investment of the ingested organisms to determine approximately their position in the plant or animal kingdom. The contents noted in the dissected gut of the different fishes studied are shown in a tabular form (Table II). No attempt has been made to analyse the food contents quantitatively, only a sorting has been made of the number of fishes showing different organisms.

(1) *Panchax panchax.*—The species is remarkable for its alertness and gregarious habits. They may be found in almost any type of water-collection, be it deep or shallow. They thrive equally well in fresh and brackish water. They are prolific-breeders, the maximum number of ova in a mature ovary varying from 48 to 186. 210 individuals of this species were dissected. These comprised specimens of all ages collected throughout the year, excepting the very dry weather when they were somewhat rare as most of the water-collections were dried up.

The results of analysis of the stomach contents are shown in Table II. This table will give at a glance an idea of the nature of food preferred by the fish. It will be seen that the fish has the greatest liking for Cyclops, Diaptoms and Daphnia and other unidentified Copepods and Cladocera. They feed also on filamentous algæ and other plant life associated with their natural haunts. Evidences of various types of insects, both adults and larvæ, in their guts are not uncommon, and often they take a mixed diet, but I do not see any evidence of special attraction of the fish towards Anopheline larvæ as has been so far supposed. Both larvæ and adults of Anopheline species were equally attacked by the fish ; roughly 10 per cent. of the fish examined were found to have devoured the larvæ or the adults of Anopheles. The adult Anophelines were probably caught in the process of emergence when they are generally helpless, or it may be that they were caught at the time of egg-laying on the surface of water.

(2) *Barbus stigma.*—This fish is very common in Lower Bengal and can thrive in any kind of water-collection. It is prevalent in both fresh and brackish water and is essentially a surface-feeder. I have dissected 96 specimens of this species representing all ages during the period November 1934 to January 1935 and again from November 1935 to April 1936. The contents of the stomach are sorted out under different heads in Table II, which shows clearly the nature of the food preferred by the fish. It will be seen that the food consists of almost entirely of the plankton flora and filamentous algæ such as Spirogyra and Oscillatoria. Only a small proportion (less than 10 per cent.) of the fish was found to have traces of animal food which consisted of minute crustaceans of the groups Copepoda and Cladocera. Only one specimen had insect remains in its gut.

(3) *Esomus danricus.*—This is a small very agile fish frequenting fresh-water tanks,

* The act of transference of the fishes from the field to the laboratory usually occupied two to three hours. The time wasted in the transport of the fishes and the consequent delay in fixation might have given a greater chance of digestion of some soft-bodied organisms in the gut of the fishes beyond recognition. But the Anophelines being not soft-bodied forms did not stand that risk, and they could always be recognised in whatever stage of digestion they may be.

TABLE II. *Analysis of the Gut-Contents of Certain Fishes.*

	Paramoecium, Euglena, Eudorina, Heliozoa	Diatoms	Filamentous algæ	Unidentified vegetable remains	Oligochæte worm	Cladocera	Daphnidæ	Copepoda (Diaptomus)	Cyclopoidea	Unidentified Crustacea	Mites	Gastropod shell	Hemiptera adult (Corixidæ)	Hemiptera larvæ	Coleoptera adult (Dytiscidæ, Hydrophilidæ)	Coleoptera larvæ (Dytiscidæ)	Perla	Lepidoptera larva	Chironomid adult	Anopheles adult	Simulid adult	Mycetophilid adult	Ephydridæ (Fly)	Chironomid larvæ	Anopheles larvæ	Anopheles egg	Mosquito pupæ	Dipterous pupæ	Chalcid adult	Ant	Unidentified insect remains	Sand or stones
1. *Panchax panchax.*	10	2	46	34		34	10	28	68	12	4	1	8	2	14	8	1	2	20	20	2	2	20	10	20	2	8	4	8	6	22	1
2. *Barbus stigma.*	7	32	33	31		3	6	3	5	5													1									6
3. *Esomus danricus.*		1		52																1												3
4. *Trichogaster fasciatus.*		20	20	2	2	2		2	10				2																		6	

N.B.—Figures represent number of specimens of fishes showing the different organisms.

ponds, etc. Under natural conditions they do not appear to be actually feeding on the surface of water. Fifty-two specimens of fish of this species dissected showed vegetable contents in the gut, and one of them had a remnant of a mosquito as well (Table II). It is likely that the part of the mosquito was accidentally engulfed in the stomach of the fish. It will also be noticed that the Diatoms and other plankton are strikingly absent in the digestive tract of the fish; this is because of the fish not being a strict surface-feeder.

(4) *Trichogaster fasciatus*.—This is also one of the most frequently met with fish in our Bengal villages. This habitually feeds on the surface of water. I dissected fifty specimens of this kind of which eight showed insect contents in their stomach. Thus nearly 16 per cent. had fed on insects none of which was a mosquito larva (Table II). The Diatoms and the filamentous algæ seem to comprise its chief source of food. Next in order of importance come the Cyclops which constitute nearly 20 per cent. of the diet.

IV. Discussion.

Excepting *Panchax*, the other fishes studied by me did not show any evidence of ingestion of insect larvæ in their guts. Even in *Panchax* which is a carnivorous fish only about 10 per cent. of the fish examined were found to feed on Anopheles larvæ in their habitat. Almost identical results were obtained by Swellengrebel and Swellengrebel (1920). Out of an examination of twenty-six guts they noted remnants of larvæ in two only. The diet of *Panchax* is so varied that it seems to have no selective food-habit, and as such cannot be relied upon as a larvicidal fish. Whatever comes along in their way, whether of vegetable or animal origin, if it is not too big for them, is devoured by *Panchax* as in the case of the types of fish studied by Seal (1910). The field observations seem to show that *Panchax* have greater attraction for small moving objects whatever they may be. The employment of fish which are not known to show a definite preference for Anopheline larvæ cannot therefore prove a success in controlling malaria in Lower Bengal.

Most of the authors seem to agree that the introduction of fish should also be supplemented by clearing the vegetation at the edges of pools and ponds and from the surface of water. In other words without the protection to the Anopheles larvæ which the vegetation is supposed to provide from the attack of fish these larvæ cannot live (Chaudhuri, Nicholls, Fry, Hora). Secondly, it has been suggested by some authors that the tanks, etc., should be kept free of large predaceous fish like murrel in order to give the small larvicidal fish a chance to prove their utility (Southwell, Hora). Thirdly, it is supposed that in the presence of a copious food-supply other than Anopheles larvæ the fish do not act as effective larvæ-destroyers (Molloy). Every practical malariologist knows how difficult it is to fulfil the conditions referred to above. It is therefore not surprising that from time to time various workers have pointed out that the control of Anopheles larvæ by the introduction of fish is not feasible (Lloyd, Seal, Southwell, Swellengrebel and Swellengrebel). In my experience the removal of all aquatic vegetation is in itself an effective anti-larval measure even in places where the supposed larvicidal fish do not occur. As Swellengrebel and Swellengrebel (1920) have put forth, the vegetation acts not so much as protection for the larvæ but as food for the larvæ as well as for the fish. Therefore by removing the vegetation we also take away the normal food factor of the larvæ, naturally the breeding is checked. There is hardly any justification for introducing the so-called larvicidal fish for the purpose of controlling the Anopheline fauna in aquatic areas cleared of vegetation.

V. Summary.

1. The food of the fishes, *Panchax panchax*, *Barbus stigma*, *Esomus danricus* and *Trichogaster fasciatus*, has been investigated by careful analysis of the gut-contents.

2. *Panchax panchax* chiefly depend on the plankton flora and fauna for their food, but have no selective food habit. They live also on a variety of insects in all their stages. Anopheles larvæ were detected in the gut of only about ten per cent. of the total fish examined.

3. *Trichogaster fasciatus* also appear to depend for nourishment on the plankton organisms and the filamentous algæ. Insects form a small part of their diet.

4. *Barbus stigma* and *Esomus danricus* are essentially vegetable-feeders.

References.

Bentley, C. A., *J. Bomb. Nat. His. Soc.*, 1910, **20,** 392-422.

Chatterji, G. C., Central Co-operative Anti-Malaria Society, Limited, Calcutta, 1934.

Chaudhuri, B. L., *J. & Proc. A.S.B.*, 1909, **5,** xxxvi-vii.

Idem., *Calcutta Med. Journ.*, 1911, **6,** 457-70.

Fry, A. B., *Paludism*, 1912, **5,** 71-74.

Gowdey, C. C., *Bull. Ent. Res.*, 1911, **2,** 182.

Graham, W. M., *Bull. Ent. Res.*, 1911, **2,** 137-39.

Hora, S. L., *Ind. Med. Gaz. Calcutta*, 1927, **62,** 187-88.

Lloyd, R. E., *J. Bomb. Nat. His. Soc.*, 1910, **20,** 1165-66.

Molloy, D. M., *Amer. Jour. Trop. Med.*, 1924, **4,** 175-94.

Nicholls, L., *Bull. Ent. Res.*, 1910, **1,** 213-218.

Osborn, H., *J. Bomb. Nat. His. Soc.*, 1907, **17,** 832-33.

Seal, W. P., *Bull. U.S. Bur. Fish.*, 1910, **28,** 831-38.

Sewell, R. B. S., and Chaudhuri, B. L., Thacker Spink & Co., Calcutta, 1912.

Southwell, T., *Ann. Trop. Med. & Parasit.*, 1920, **14,** 181-86.

Swellengrebel, N. H., and Swellengrebel, J. M. H., *Jour. Trop. Med. & Hyg.*, 1920, **23,** 3, 77-79.

Wilson, H. C., *Bull. Madras Fish.*, 1917, **11,** 161-72.

Comparative Study of the Determination of Iodine Values.

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I. Introduction.

SEVERAL methods are available to the chemist for the determination of the iodine values of oils and fats. It is undoubtedly of interest to examine these, critically, with a view to determine their adaptability for the investigation of different types of oils and fats under varying conditions.

One of the earliest methods for the determination of iodine values is that due to Hübl.[1] This was followed by the method introduced by Wijs.[2] Later, the methods of Rosenmund[3] and of Margosches[4] came into use but were given up in favour of the other methods. The method due to Hanus[5] has received official recognition in Germany and America for the last many years, and more recently the one proposed by Kaufmann[6] has found favour and is already officially recognised in Germany.

In choosing a method for the determination of the iodine values the following points have to be taken into consideration:—(1) The halogen or the halogen compound used should react with the unsaturated part *only* and form additive compounds; no substitution compounds should be formed in the reaction, even after a prolonged period of contact; (2) The reaction should be rapid, irrespective of the nature (non-drying, semi-drying, or drying) of the oil or fat; (3) The chemicals used should not be very expensive; and (4) The reagents should be capable of being prepared easily and quickly, and should not undergo a change on keeping. The quantity of the substance required has also to be considered in choosing the method and the one which can be adopted for micro-quantities should be preferred.

With a view to compare the accuracy of the four methods, a few typical oils were selected and the iodine values determined for varying periods of reaction. The following oils were used.—(A) *Non-drying*:—Mahua (market sample), Ground-nut (cold-pressed in the laboratory); (B) *Semi-drying*:—Sesame (cold-pressed in the laboratory); (C) *Drying*:—Linseed (cold-pressed in the laboratory). The results obtained are tabulated below:—

(A) Non-Drying Oil.

Table I(*a*).

	Hübl	Wijs	Hanus	Kaufmann
Minimum Time Recommended ..	6 to 8 hrs.	30 min.	30 min.	30 min.
Minimum Quantity ,, ..	$\frac{40}{I\cdot V.}$ gm.	0·15 to 1·0 gm.	0·4 to 0·8 gm.	0·5 to 1·0 gm.
Quantity Taken (Godbole) ..	2·0 to 2·5 gm.	0·5 to 0·7 gm.	0·7 to 0·8 gm.	0·5 to 0·7 gm.

TABLE I(*b*).
Mahua Oil.[7]
Iodine Value 53–68.

Time	Temp.	Hübl	Wijs	Hanus	Kaufmann
15 min.	33°C.	..	58·57	56·65	57·94
30 min.	,,	..	59·7	57·69	57·87
45 min.	,,	..	59·24	58·35	58·26
1 hr.	,,	..	60·1	57·99	58·30
2 hrs.	,,	..	60·58	58·3	58·09
4 hrs.	,,	53·23	61·38	57·04	58·93
12 hrs.	,,	55·9	..	..	..
24 hrs.	,,	54·1	..	..	..
48 hrs.	,,	50·77	..	..	..

TABLE I(*c*).
Groundnut Oil (pressed in the Laboratory).
Iodine Value 86–98.[8]

Oil	Time	Temp.	Hübl	Wijs	Hanus	Kaufmann
Groundnut	15 min.	30°C.	..	89·84	88·14	90·03
	30 ,,	,,	..	91·50	88·04	90·67
	45 ,,	,,	..	92·41	89·18	90·51
	1 hr.	,,	..	92·50	89·03	90·80
	2 hrs.	,,	..	93·77	88·33	91·1
	4 ,,	,,	83·5	95·61	91·68	91·41
	6 ,,	,,	..	..	..	..
	8 ,,	,,	..	..	..	..
	12 ,,	,,	86·25	..	..	..
	24 ,,	,,	83·98	..	..	..
	48 ,,	,,	74·08	..	..	..

TABLE II.*

Oil	Time	Hübl	Wijs	Hanus	Kaufmann
Groundnut	15 min.	..	..	88·9	..
	30 ,,	..	..	..	89·2
	50 ,,	..	..	88·7	..
	1 hr.	..	89·50	..	..
	2 hrs.	..	89·6	88·6	89·5
	4½ ,,	88·5	..	..	..
	6 ,,	..	..	..	88·8
	8 ,,	..	89·2	..	..
	12 ,,	89·4	..	..	..
	24 ,,	88·3	91·8	91·2	88·4
	48 ,,	88·0	..	..	..

* From *Studien auf dem Fettgebiet*, of H. P. Kaufmann 1935, p. 26.

(B) Semi-Drying Oil.

Table III (*a*).

	Hübl	Wijs	Hanus	Kaufmann
Minimum Time Recommended ..	8 to 10 hrs.	1 hr.	30 min.	30 min.
Minimum Quantity ,, ..	$\frac{40}{I\cdot V}$ gm.	0·15 to 1·0 gm.	0·2 to 0·4 gm.	0·2 gm. (approx.)
Quantity Taken (Godbole) ..	0·3 to 0·4 gm.	0·2 to 0·3 gm.	0·3 to 0·4 gm.	0·2 ,,

Table III(*b*).

Iodine Value 103–112.[9]

Oil	Time	Temp.	Hübl	Wijs	Hanus	Kaufmann
Sesame	15 min.	30°C.	..	111·25	103·5	..
	30 ,,	,,	..	111·4	105·0	105·25
	45 ,,	,,	..	111·3	106·15	106·4
	1 hr.	,,	..	112·0	106·5	..
	2 hrs.	,,	..	112·15	105·1	106·0
	4 ,,	,,	100·75	112·2	108·85	106·7
	12 ,,	,,	101·2	..	..	..
	24 ,,	,,	97·8	..	..	..
	48 ,,	,,	94·7	..	..	..

Table IV.†

Oil	Time	Hübl	Wijs	Hanus	Kaufmann
Sesame	20 min.	..	..	109·0	..
	30 ,,	..	112·6	..	110·6
	1 hr.	..	112·9	110·4	..
	2 hrs.	..	112·2	110·9	111·8
	4 ,,	109·4	..	..	..
	6 ,,	..	..	..	112·6
	8 ,,	..	112·4	..	..
	24 ,,	110·0	115·8	113·7	111·2
	48 ,,	109·1	..	..	..

† From *Studien auf dem Fettgebiet*, of H. P. Kaufmann, 1935, p. 25.

(C) Drying Oil.

Table V(*a*).

	Hübl	Wijs	Hanus	Kaufmann
Minimum Time Recommended ..	12 to 18 hrs.	2 to 6 hrs.	1 hr.	45 min.
Minimum Quantity ,, ..	$\frac{40}{I\cdot V}$ gm.	0·15 to 1·0 gm.	0·1 to 0·2 gm.	0·1 to 0·12 gm.
Quantity Taken (Godbole) ..	0·2 to 0·25 gm.	0·1 to 0·17 gm.	0·1 to 0·15 gm.	0·15 gm. (approx.)

TABLE V(*b*).

Linseed Oil—Cold Drawn (pressed in the Laboratory).

Iodine Value 169-192.[10]

Oil	Time	Temp.	Hübl	Wijs	Hanus	Kaufmann
Linseed	15 min.	30°C.	..	173·8	168·1	173·5
	30 ,,	,,	..	176·6	169·85	174·9
	45 ,,	,,	..	177·4	171·4	175·2
	1 hr.	,,	..	177·6	170·6	175·5
	2 hrs.	,,	..	178·7	173·75	175·3
	4 ,,	,,	160·2	179·6	176·0	175·6
	12 ,,	,,	163·4	..	..	..
	24 ,,	,,	159·3	..	..	..
	48 ,,	,,	147·15	..	..	..

TABLE VI.[11]

Oil	Time	Hübl	Wijs	Hanus	Kaufmann
Linseed (Cold Drawn)	15 min.	..	..	171·1	..
	30 ,,	..	175·5	..	..
	45 ,,	..	..	171·1	..
	1 hr.	..	174·5	..	..
	2 hrs.	..	174·6	173·2	171·5
	4 ,,	169·8	..	..	..
	5 ,,	..	..	..	171·6
	8 ,,	..	175·7	..	171·6
	12 ,,	173·6	..	..	..
	24 ,,	172·1	180·7	178·0	172·8
	48 ,,	170·5	..	..	172·4

It will be seen from the experimental data furnished that the results obtained by Hübl's method are not only generally low, but are also varying. The results obtained by the method of Wijs are higher than those obtained by the method of Hanus and of Kaufmann, obviously indicating the formation of substitution compounds, in addition to the normal additive compounds. In the case of the method of Hanus, the results are found to be steady, but after a prolonged action of several hours, slightly higher results in the iodine values (pointing to the formation of substitution compounds) are obtained. The method of Kaufmann gives results which are uniformly steady, and should therefore be the method of choice. The unpublished parallel experiments quoted from the recent book of Kaufmann (*Studien auf dem Fettgebiet*) also point to exactly similar results.

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[1] *Jour. Soc. Chem. Ind.*, 1884, 641.
Dinglers, *Polyt. Jour.*, 1884, **253,** 281.

[2] *Chem. Revue*, 1899, **1** ; *Ber.*, 1898, **31,** 750.

[3] Rosemund, K. W., und Kuhnhenn, W., *Ber.*, 1922, **56,** 1262, 2042.

[4] Margosches, u, Mitarb, *Ztschr. angew. Chemi*, 1924, **37,** 334, 982.

[5] Hanus, *Ztschr. Unters. Nahr.–u Genussmittel*, 1901, **4,** 913.

[6] Kaufmann, H. P., *Ztschr. Unters. Lebensmittel*, 1926, **51,** 5.

[7] Holde Bleyberg, *Kohlenwasserstoföle und Fette*, Julius Springer, Berlin, 1933, 7th Edition, p. 788.

[8] *Ibid.*, p. 792.

[9] *Ibid.*, p. 794.

[10] *Ibid.*, p. 800.

[11] Kaufmann, H. P., *Studien auf dem Fettgebiet*, 1935, **25** ; *Verlag Chemie, G.M.B.H., Berlin.*

OBITUARY.

Prof. K. K. Mathur.

PROFESSOR KRISHNA KUMAR MATHUR's premature death on July 18, 1936, deprived India of an eminent geologist and an educationist. Though of late he had been suffering from a prolonged illness from myloid leukæmia, an incurable disease, the news of his death has come as a sudden shock to every one who knew him. Educational career of Professor Mathur has been all through very brilliant. In all examinations he stood first and secured merit scholarships. After finishing the secondary education he joined the Agra College. It was here that he came in close contact with the inspiring personality of Prof. N. C. Nag. He graduated in the year 1915 and topped the list of the successful candidates of the Allahabad University. The Government awarded him a scholarship for studies abroad in the year 1916. This he availed in spite of the troubled atmosphere of the last Great War in Europe. In England he prosecuted his studies at the Imperial College of Science and Technology, where he took the Associateship of the Royal School of Mines in Mining and Mining Geology, and the B.Sc. degree in Mining, with First Class Honours, of the University of London. There too he stood first amongst the successful candidates of his batch and was awarded the De La Beche Medal.

Late Prof. K. K. Mathur.

Soon after his return to India Prof. Mathur's services were secured by the Benares Hindu University as the University Professor of Geology in the year 1921. There he soon established himself as a great teacher and administrator. The Department of Geology owes its growth and development to Prof. Mathur who was its Head from the very beginning. His love for the science of geology was great and he was keenly devoted to it. His personality attracted students from all parts of India. At Benares he built up a school of geology, which is all India in its character. His indomitable spirit in the face of hardship and his great love for the science of geology, were a source of great inspiration to his students, who are spread far and wide in India and some of them hold important offices. His colleagues in the University held him in the highest esteem, and when he was appointed Principal of the College of Science constituted in 1935 every one was indeed very happy at the selection.

In the field of research his principal contributions comprise the Petrology of the Deccan Trap Igneous Activity. He carried on investigations of the study of the various differentiates and threw much light on the genetic processes leading to the formation of the different types. His Presidential Address to the Geology Section of the Bombay Session of the Indian Science Congress, 1934, on this subject will continue to be a valuable work of reference for a long time to come. His research activities also extended to stratigraphy, mineralogy and colloidal chemistry.

Amongst the scientists in India he held a prominent position. He was Vice-President of the Geological, Mining and Metallurgical

Society of India for two sessions. He was a foundation Fellow of the Academy of Sciences, U.P., now the National Academy of Sciences, India, the Indian Academy of Sciences, and of the National Institute of Sciences of India. He presided over the Geology Section of the Indian Science Congress, held in Bombay in the year 1934.

In the Benares Hindu University he was a prominent figure in all the administrative and academic bodies. He was a member of the Court, the Council, the Senate and the Syndicate, and had been the Dean of the Faculty of Science for two consecutive terms. He also served on the Faculties of Arts and Ayurved and numerous other boards of studies. He acted as the Honorary Secretary to the Hindi Publication Board, and it was due to his enthusiasm that a splendid set of scientific books in Hindi, the principal Indian language, was published. He was President of a number of local social bodies and took an active interest in all of them.

On the personal side, Prof. Mathur was a man of strong principles and high ideals. As an administrator his sense of justice was great, which won for him love from all quarters. He was strict in imposing rules but very liberal in judging faults. He was simple, sincere and a great philanthropist. His purse was always open for the poor students and for the cause of science. He carried his greatness with charming modesty, and was a paragon of politeness and gentlemanliness. He was a selfless and conscientious worker. Whatever work, whether great or small, of scientific or of social nature, he took up he used to put his heart and soul into it with the result that he used to overwork himself, a practice which he continued even during his illness. His friends and doctors constantly advised him not to work so hard. But all such advice was vehemently opposed as life to him without work had no meaning. He hardly enjoyed a vacation. As the nature of his duties demanded his presence at the University all through the working session, he had to lead geological excursions during the hot months of May and June and that too sometimes to places like Rajputana, Cutch and Kathiawar. This prolonged strain of work with little rest was perhaps responsible for bringing such a brilliant career to a close at the early age of forty-three. May his soul rest in peace!

B. Jayaram (1872-1936).

THE death of Mr. B. Jayaram, F.G.S., retired Director of the Mysore Geological Department, on the 4th December 1936, deprives the State of one of its pioneer geologists who were mainly responsible for its preliminary Geological Survey.

Bangalore Jayaram was born in March 1872 and after undergoing a course of study in physical science at the Central College, Bangalore, he joined in 1895 the Mysore Geological Department as one of the batch of apprentices who were selected when that department was organised. During the period of his apprenticeship, the first two years of his official career, he was under practical training along with the rest of the apprentices, in Geological Survey and mapping under the guidance of the distinguished geologists Bruce Foote and Dr. Evans. In 1901 he was sent on deputation to England for a course of further study in Petrology under the late Prof. Judd, at the Royal College of Science, London.

Passing through the several grades of Assistant Geologist, Senior Geologist, and Deputy Director, Mr. Jayaram rose, in 1919 to the position of the head of the department as its Director and continued to hold this post till his retirement from service in February 1927. Initiated by Dr. W. F. Smeeth into the study of complex crystalline schists, Mr. Jayaram spent the early years of his service in a detailed investigation of the structure and character of the rocks of the Kolar Gold Field, as a result of which he prepared an elaborate geological map of the area and contributed several short notes on the nature of the rock types exposed in the region. From 1908–13 he was engaged in surveying the southern portions of the Mysore district and the hilly tracts of Closepet. Snbsequent to 1914 and till the period of his retirement, he examined many portions of the central and northern parts of the State to effect the needed revisions in the preliminary mapping. His work during these later stages has raised many doubts and controversial questions which unfortunately he could not completely investigate, and as such he has contributed only

short descriptive notes of the several areas he examined, drawing attention to any specific points which in the light of his views needed further investigation. Though an indefatigable field geologist and a very keen observer, Mr. Jayaram was not a prolific writer and consequently left unsaid many of his views which might have been of good service to others. He believed in silence and preached silence and seldom encouraged free discussion of views.

Mr. Jayaram was an all-round sportsman and an able cricketeer. He was selected to play for India as one of the teams which toured England in 1911 and after his return from this tour owing to the increasing responsibilities in his official life, he discontinued taking active interest in cricket. His recent article "On Reminiscences of our Cricket days" contributed to the "Hindu", only a couple of months prior to his death, giving a vivid account of his sporting days, should still be green in the minds of the cricket enthusiasts in India.

As a man Mr. Jayaram was somewhat impetuous and occasionally short tempered which often led him to estrangement with some of his associates. But still, he was large hearted and was generous sometimes, even to a fault. He liked the unostentatious native wit of the uneducated villager much better than the book learning of the modern college trained graduate.

After his retirement from service Mr. Jayaram took to fruit culture as a hobby and practically withdrew from the bustle and scene of the City life to seclude himself in his garden villa some distance from the City, where he spent the rest of his days amidst peaceful surroundings and rural scenes till within a few days of his death.

B. R. Rao.

Vitali's Test for Mydriatic Vegetable Alkaloids.

By K. R. Ganguly, M.Sc.
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In India Dhatura poisoning cases are of frequent occurrence. In fatal cases, due to climatic conditions of the country, sometimes decomposition sets in before the autopsy can be held. Under such circumstances when a mydriatic alkaloid is detected in the viscera, it is desirable to supplement the mydriatic test by Vitali's test if fragments of Dhatura seeds are not found in the contents of the stomach or intestine.

In connection with the application of Vitali's test, it is found from the literature on the subject that some use ordinary nitric acid for the oxidation, others, fuming nitric acid. Some prefer heating the basin for a short time over a flame before evaporating the excess of nitric acid on water-bath, while others omit this preliminary heating. Regarding alcoholic potash some advocate the use of 4 per cent. solution, while others use a 10 per cent. solution.

Experiments performed by me showed that it makes no difference in the reaction, whether ordinary or fuming nitric acid be used, but heating the basin over a flame for a short time prior to complete evaporation on the water-bath gives better reaction.

As for the reagent alcoholic potash, it was found that the higher the strength of the alcohol, the better was the result. A series of solutions of KOH in absolute alcohol ranging from 2 per cent. to 20 per cent. KOH was prepared and the tests carried out. The 2 per cent. solution yielded no colour, the 3 per cent. solution gave a faint positive reaction, whereas definite positive reactions were obtained with solutions of 4, 5, 10, 15 and 20 per cent. strength.

The Vitali's test carried out as mentioned above was noticed to be less sensitive in summer than in winter. But there was marked improvement in the reaction, when the basin containing the residue under test was cooled by placing it on ice for a few seconds avoiding the formation of dew drops inside it.

As for the colour developed by Vitali's reaction, in my experience, atropine, hyoscyamine or hyoscine all give a purple or a purplish violet, gradually or rapidly fading away, without giving a definite red shade as has been noted by others. The time factor for the fading of the colour is dependent on the amount of alkaloid present.

The test when carried out in the following way gave excellent results.

The alkaloidal residue extracted by the Stas-Otto process from the viscera is obtained in a dried condition in a porcelain basin. It is then treated with a few drops of nitric acid, the basin is passed over a bare flame till acid fumes are given off and then the liquid is completely evaporated on water-bath avoiding dust to fall in the basin. After cooling the basin,—if necessary by placing on ice for a few seconds avoiding the formation of dew drops in it, the oxidised alkaloid is touched with a glass rod moistened with cooled freshly prepared saturated solution of KOH in absolute alcohol.

By this process 0.0004 mg. of atropine could be detected by the Vitali's test in place of 0.001 mgm. of the alkaloid as was claimed by the author of the test.

If the Stas-Otto extract contains excessive impurity as happens when putrefaction of the cadaver has set in, it interferes with the test. In such cases the residue obtained, after evaporating the excess of nitric acid, is often distinctly brown and the characteristic colour of the atropine group of alkaloids developed on the addition of alcoholic potash is either completely masked or is faint. The presence of other alkaloids also, particularly strychnine, interferes with the test. Strychnine after treatment with nitric acid leaves a yellow residue which, with alcoholic potash, gives a faint transient purple immediately changing to reddish brown. In such cases the interfering substance may be completely got rid of by the following process, and then the Vitali's test may be applied with success.

If on the addition of alcoholic potash to the residue oxidised with nitric acid, the colour reaction of the atropine group of alkaloids is not definite, the residue treated with alcoholic potash is transferred by means of distilled water into a separating funnel. The alkaline liquid is then shaken up twice or thrice with petroleum ether. The combined petroleum ether extract after separation is shaken up several times with faintly alkaline water, until the watery layer shows no more colour. The petroleum ether extract is then transferred into a round-bottomed porcelain basin and evaporated off. It is of advantage to concentrate the residue at the bottom of the basin by washing down the side with a few drops of chloroform and then removing the chloroform, first by spontaneous evaporation and finally on a water-bath. If now the alcoholic potash be added to the cooled residue, the characteristic colour of the atropine group of alkaloids is distinctly developed. In case traces of the interfering substance be still present, a second extraction with petroleum ether may be done.

Vitali's test needs only to be applied when a mydriatic alkaloid is found to be present.

This investigation was carried out under the facilities kindly afforded to me by Mr. D. N. Chatterji, B.A., B.Sc., F.I.C., the Chemical Examiner to Governments, United Provinces and C. P., in his laboratory. I am indebted to him for his kind permission to send this paper for publication.

Peking Man.

THE interest attached to the recent discovery of additional material in the form of five new skulls of *Sinanthropus pekinensis* in a more or less perfect state of preservation has proved to be considerable. The new skulls are even better than the older finds and what is more important, they are adult skulls, while hitherto, the skulls of only adolescents were known. These five skulls along with a sixth which Prof. F. Weidenreich (Director of the Caenozoic Research Laboratory of the Geological Survey) is reconstructing from fragmentary material will form the "richest and most complete collection of human fossils ever recorded, unique in every respect".

While it is still too early to forecast the trend of the conclusions which these discoveries may lead to about the ancestry of Man, it is probable that Prof. Weidenreich's earlier observations that the Peking skull stands intermediate between those of *Pithecanthropus* and Neanderthal man, may be substantiated. It is to be hoped that every assistance and co-operation will be afforded to Prof. Weidenreich in the important task he has undertaken.

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Presidential Address.

The Indian Village—Its Past, Present and Future.

By Rao Bahadur T. S. Venkatraman, B.A., I.A.S., F.N.I.

Introduction.

I TAKE it no apology is needed in these days for talking about any aspect of 'village and village life'. The city and the town which were holding a complete thraldom over the public mind all these years are losing their glamour somewhat in spite of their admittedly alluring attractions; and the 'village' would appear to be getting increasing recognition, particularly in our country and in recent times.

I propose to speak to you to-night under the caption 'The Indian Village—Its past, present and future'. You might perhaps question my claim to speak on this subject as all my official life and thought for the last quarter of a century has been linked up almost entirely with sugarcane. But this very work has often taken me to the country-side in various parts of India and my contact with the Indian village has been fairly intimate. While at my special work I had perforce to witness the pleasures and tragedies of the villager and watch the changes that are steadily coming over the village. Secondly, most of us—in this agricultural land of ours—have come from villages and are in fair contact with village life either directly or through our kith and kin.

One easily noticed change, in the village, is the migration of the villagers to the town. The richer of the villagers show a tendency to shift themselves to the nearest town or city for the education of their children, for better medical help or for the characteristic amenities associated with urban life. Secondly, the more intellectual of the younger generation, who first migrate to the towns for their studies or to seek employment, do not generally return to the village, but settle in some town which they find more congenial for the full scope of their talents. If they do pay a visit to the village it is either to see an old relative who is too conservative to move to the town or in connection with some matter which renders their presence in the village unavoidable. Such visits are made of as short duration as possible and they get back to the town with almost a sense of relief.

Position of India with Reference to Space and Time.

But before getting into the subject proper it is necessary to record here a few general observations on the position of our country with regard to both space and time view-points. With China, Japan and the South-Eastern islands, India is situated in a comparatively densely populated area of the globe—about half the population of the world being crowded into a tenth of the Earth's land region. This has had its effects on the type of agriculture practised in the country, the selection of crop for cultivation and the life of the people as a whole.

Secondly, along again with China, India possesses a civilization and culture which was at least contemporaneous with, if not antecedent to, the civilizations of Egypt, Mesopotamia, Greece and Rome. After making considerable progress this civilization has, however, remained in a more or less quiescent and petrified state in our villages for well nigh two to three thousand years, little influenced by the great progress made by the West during the latter part of the same period. It is only within comparatively recent times that the Western civilization has come to spread into and influence the countryside. In more senses than one the Indian town represents the dynamic West with all the vigour of youth and the village the comparatively quiescent East. Certain of the problems of the village to be discussed hereafter will be found traceable to the inevitable contact between the two.

Aryan Colonization of India and Types of Villages.

The Aryans, who entered the country through the North-West route, first occupied the Indus valley and the Punjab plains and later spread to the east of the Jumna as far as the Saraswathi. Subsequently they spread into Bengal and from there would appear to have sent out expeditions

by sea to Burma, Ceylon and Java. The Vindhya ranges and the Aravalli hills long acted as an effective barrier against large movements southwards into the Deccan and South India. The country to the south of these ranges remained for long Dravidian, though increasingly influenced by Aryan culture from the North.

The Ryotwari village.—The new Aryan colonists naturally found plenty of land to settle in and the obvious advantages of group formation brought into being two main types of villages. One was the type similar to what is now termed 'ryotwari' where each family or group of persons took up as much land as they could cultivate depending on the number of cattle and able-bodied men in the unit. Site for the village was chosen at some convenient spot such as the banks of a river or canal or proximity to other sources of water-supply. The persons constituting the village chose a headman who exercised all powers on behalf of the whole community. This type of village was generally associated with peaceful conditions.

Joint village.—The other type called 'Joint Village' by Baden Powell was founded by powerful families or clans not necessarily agriculturists. The government of such villages was by the well-known Panchayat system and occasionally a group of such villages belonged to the same clan or owed some kind of allegiance to the same warrior chieftain in return for the protection they enjoyed at his hands. In these villages the cultivating classes were sometimes in the position of tenants. 'Ryotwari' villages sometimes got converted into 'Joint Villages' through conquest by some warrior chieftain.

The Great Change in the Village.

To realize fully the present conditions of the Indian village and understand its problems it is necessary to briefly notice here the changes that are coming over it and the reasons for that change. The Indian village of ancient times was practically a self-contained, self-governing unit, having but little contact with the outside world. It grew all the crops required to meet all its simple needs and the surplus of good years was stored in the village granaries as a provision against future unfavourable seasons. The people of the village lived like the members of a big family under the accepted leadership of the village elders—the Panchayatdars. Land was plenty, needs few and there was a great deal of contentment. The villager's outlook and knowledge were limited rarely extending beyond the confines of his own village and the villager's life ran an even course from day to day. This had been the condition for well nigh two to three thousand years.

One very important result of the contact with the West has been the development of the export and import trades which have affected profoundly the kind of crops grown and both the occupation and mode of life of the villager. It is steadily dragging him out of his isolation and throwing him into the world currents of commerce and industry. He is not content to grow crops to meet the needs of his own village but finds it more 'profitable' to grow what are termed 'commercial' crops for outside markets as distant as New York or London. This has upset the old time food centred economics of the village and rendering them increasingly money centred. The more enterprising and intelligent of the villagers are attracted by the commercial life and tend to shift themselves to the nearest town or city temporarily in the beginning but often permanently in the end. It is no wonder that such great changes have brought in their train a variety of problems connected with our villages.

The Present-day Village.

Village Agriculture.

As agriculture is the sole occupation of the villager its present condition and its effect on the economics and life of the villager are well worth consideration. One outstanding feature connected with Indian agriculture is its great dependence on the monsoons. In spite of the great irrigation works—some of them the largest in the world—and the steady advance in the matter of tapping underground water, it has been estimated that seven-eighths of our agriculture is yet dependent on the monsoons.

Secondly, the villager is so little in touch with world markets wherein the results of his labours are evaluated and sold, that a large portion of his profits is intercepted by the intermediate agencies that market his produce.

Thirdly, land available for crop growing has not increased to the same extent as increase in population. True some new lands have been brought under the plough and yields from existing lands have increased somewhat, but such increase is much less than the increase in population.

Fourthly, possibility of large augmentation in acre production is severely handicapped by a variety of causes such as Sub-division and Fragmentation of holdings and the prevalence of rigid social customs and religious sentiments which cause the waste of such valuable manures as night soil and cattle dung and adversely affect the business aspect of agricultural production. Both Sub-division and Fragmentation are inter-related to each other and result from the same cause, *viz.*, the mode of inheritance of landed properties as obtaining in both the Islamic and Hindu laws.

Village Cattle.

The Aryan settlers loved their cattle and valued them highly. A grazing waste round each has been the standard feature of the Indian village. Unlike China and Japan where the consumption of milk as food is considered a disgusting habit, this article has been highly valued in our land and extensively used as food from ancient days. This is fortunate for a country like ours which otherwise is largely vegetarian. Milk was not banned even in the case of the semi-recluse who was denied most other articles of diet. In the Brahmanical period the daily prayer included an invocation for the health and prosperity of the cow.

The cattle represents sometimes the heaviest capital outlay of the cultivator next only to land and he loves them almost to a fault.

But this very attachment and religious regard to the cattle—particularly the cow—is now working to their disadvantage. India is unique in possessing an enormous amount of cattle without making profit from its slaughter. The old and the weak are allowed to deplete the fodder stock of the village with the result that the fitter and hence the more useful ones do not get their due share. Cattle maintenance is not looked upon as a business proposition and the sentiment towards them is similar to that of a rider to the old horse which had served him well when he was fit and strong, or of the lady aristocrat to her pet dog or cat in the West. The sentiment is too deep-seated for a rapid change.

The Motor, the Oil-Engine and Electricity are steadily replacing cattle power (largely of the male sex) for transport and water lifting. On the other hand, the demand for milk and milk products is likely to increase in the future and it is desirable it should be so. Fewer but better type of cattle and tended with greater knowledge of their needs, are indicated in the future. Castration in as painless a manner as possible to work out the uneconomic types from the village stock is the crying need of the countryside. The world is getting accustomed to such ideas even in the human species. With increasing knowledge of factors determining the sex of the fertilized egg will science be able to increase the number of heifers as perhaps in the future we might need more cows and less bullocks ?

Village Labour.

For agricultural labour the Aryan colonists would appear to have employed largely the local people—the Dravidians and aborigines. The Indian labour is low both in wages and efficiency, certain extremist opinion equating a week's labour of the Indian to a day's of the Westerner.

But the demands of agriculture are such that, whereas at certain periods a large force of labour is needed, there is no demand during other parts of the year. This is particularly the case where the bulk of the area in the village is under the same crop. In the absence of work and hence wages all the year round, the labour migrates to other places with the result that, at the time of peak demand (as during paddy transplantation) there is labour scarcity. Crops like the sugarcane which need labour all the year round, greater diversity of crops or subsidiary occupations are needed for stabilizing the labour demand.

The Villager (and His Indebtedness).

Having briefly considered certain important aspects of village life, we are now in a position to consider the present condition of the villager himself. Though till recently but little affected by the changes around him, on account of his isolation, both mental and physical, he is being made increasingly aware of the changes around by the extension into the village of such symbols of modern life as the Post and Telegraph, the bicycle and the motor bus. Frequently also the village is visited by the townsman who is only too eager to demonstrate before the awe-struck villager the elegances and conveniences of urban life.

Economically he finds himself in a very disadvantageous position owing to his steadily diminishing agricultural income in contrast with increasing expenditure due to changes in living even in his own household. Innovations in dress and habits and new wants like tea and coffee are steadily forcing up family

expenses. While the community life of interdependence has ceased to exist, the medieval social structure like the joint family system still persists rendering the villager's life unbalanced.

Dependant as he is solely on agriculture, the need for money always exists. This is true of the agriculturist all the world over and results from the fact that, whereas agricultural income comes in only at particular times like harvest, his expenditure is of a monthly if not of a daily nature. Extra profits from an exceptionally good year are more often wasted in urbanizing his surroundings than being put by as reserve against lean years. The heavy indebtedness of the Indian villager is well known and has attracted the attention of all that have cared to study the village.

The villagers' debts are also often unavoidable. It has been calculated that nearly 90 per cent. of a villager's expenditure is on such essentials as food, clothing, rent and taxes, thus leaving but little margin for unexpected reverses such as crop failures or floods or sudden cattle mortality. Expenses on marriages and funerals, which to the villager are equally unavoidable because of his traditional ideas, are other sudden items of expenditure. The margin of extra income is so narrow that the loss of a buffalo or the long illness of the working member in the family is known to drop the villager down in the social scale sometimes never to recover to his original position. The only security he can offer against such debts is the land, his only possession in this world, and once pledged he finds it difficult to redeem it.

While on the subject of the economics of the villager it will be appropriate to consider here the various types of waste that are taking place in the village. Foremost, perhaps, is the agricultural waste resulting from the uneconomic sub-division and fragmentation of land which precludes its cultivation to maximum benefit. Then come the waste of cattle and human labour due to fragmentation, the drain of village money by way of interest on loans raised by the villagers and loss of valuable manures like human and cattle voids. Cattle manure is wasted as it is needed for fuel. It is such a suitable fuel in the Indian household that a substitute alone will be operative in bringing about its rapid discontinuance as fuel. Human voids instead of being utilized as in China and Japan, are allowed to render the streets and surroundings unsanitary and poison the clean country air. There is considerable waste of both energy and material resources through adherence to sentiments and habits which, perhaps useful in olden times, are useless and wasteful under the changed conditions of to-day.

One important waste which has to my mind far-reaching results is that caused through forced idleness. This is because agriculture, which is often the sole occupation, is not able to keep the villager busy all the year round. This forced idlenesss is very harmful, changes his whole outlook on life and lowers his character in many ways. No tonic is so good as healthy and steady work all through the year and this is denied to the average villager. The comparative prosperity of villages located near towns or industrial centres proves the advantages of employment all through the year.

The Exodus from the Village.

The most serious of the unfavourable changes coming over our villages is the steadily increasing exodus of people from the village to the town. There is little doubt that the villages were comparatively more populous in the olden days. One main reason for this exodus is the growing inadequacy of agricultural income not supplemented by income from other sources. A second reason is the shifting of the main activities of life to the town. Educational facilities and other urban conveniences are increasingly attracting the villagers to the town. Dr. Mann was struck by the significant absence from a Bombay village of youths between the ages of 14 and 20; and this is largely true of other provinces as well. They had gone out for education or to seek employment.

Apart from the number, the quality of human material contained in the exodus constitutes a serious drain. Take, for instance, a family of four sons all of whom had gone to the nearest town for education. The successful ones get employed away from their villages in due course and rarely return to it except if at all in old age. The unsuccessful ones, on the other hand, with nothing else to do perforce return to the village and settle there, thus increasing the pressure on the land often disproportionately to their contribution to the village assets. Secondly, the richer landlords who, by their superior resources, could, if they cared, undertake experiments or launch fresh agricultural ventures, are attracted to the town and leave behind in the village their less resourceful

brethren. Similarly, the capable artisan leaves for the town to make the most of his talents. Culture is now town-centred and there is little scope in the village for the full development or unfolding of one's talents. In the olden days when the village was practically autonomous and had its own funds to cater to the needs and amenities of the village the opportunities in the village were greater; and it was possible to retain in the village at least a portion of the intelligentsia, though even then the best of talents resorted to the capitals or courts of Kings for patronage.

THE FUTURE OF THE INDIAN VILLAGE.

After this rapid review of the Indian village in the past and the changes that have been coming over it up to the present time we are now in a position to consider its future. There is little doubt that the general tendency so far has been for the village to steadily go down in prosperity and importance in contrast to the town which has increasingly drawn the best from the village. The question to consider is, if this is in the best interests of our country and, if not, are any steps needed to place the village in a better position than now. Does the future lie in a greater and further development of urban life, evolving measures that would somewhat mitigate the inevitable disadvantages associated with it or does the situation need radical changes in the village and village life, importing into it certain characteristics of the town?

In spite of its having become trite, the statement that ours is an agricultural country warrants repetition on account of its far-reaching effects on all our activities. The plough with a pair of oxen is perhaps the one symbol that would properly represent India as a whole with its different classes and communities. Secondly, the rapid increase of population in our country and China has become a byword and this renders incumbent a further increase of agricultural production. Science has so far not succeeded in growing crops on the roofs of houses or on road-sides in towns and the best achievements of agriculture have been in the countryside. The clearly indicated line of advance for the future, therefore, lies in improving rural conditions and rendering our villages better and more efficient in the discharge of duties set to them by the country as a whole, *viz.*, (1) the proper and adequate feeding of the steadily increasing population, and (2) rearing a healthy stock of men and cattle and maintaining them in a fit condition.

Both town and village are needed for the full and complete development of our country as a whole. The town is a natural and inevitable product in this development. 'If God made the country' the town was and is being made by man, His agent, and in response to forces no less natural in the broad sense of the term. Ours has been and still largely is a land of villages but the towns have risen up and are bound to multiply and expand in the future. In recent times there has been a growing tendency to centralize culture and activities in the town to the disadvantage of the village; and the towns and cities have in a sense grown at the expense of the village.

But each has certain specific advantages and inevitable defects. In crop growing, when one comes across two types both of which possess desirable characters, the crop servant—called the Breeder—tries to raise hybrids between them for producing kinds which might combine in themselves the good points of both and eliminating as far as possible the defects of either. This process of hybridization is neither new nor recent. Nature has been doing this since the beginning of life and the existing crop types are the result of such so-called 'natural' hybridization and selection. A similar procedure is indicated between the town and the village and such a process is already in progress. The open air extensions that have grown round towns in recent years—with compound houses and gardens—indicate the attempt to ruralize the town in the matter of health and surroundings, while the Post Office, the rural dispensary, the school, and even the bus horning its way through the village are in the nature of urbanizing the countryside. Suburban colonies also represent such an endeavour to combine the advantages of both country and town life. While the process is already in action it is desirable to speed it up by conscious endeavour.

Improving Agricultural Efficiency.

Elsewhere we have considered certain serious handicaps the present-day village agriculture is labouring under. Thanks to the good work inaugurated by Lord Curzon's Government about thirty years ago reinforced and supplemented by the elaborate and far-reaching recommendations of the ROYAL COMMISSION ON AGRICULTURE of 1930, we are now in a position to feel that technical advances in agriculture and allied sciences can be taken to have been provided for. The Imperial Council of Agricultural

Research, a lusty child of the Royal Commission, has already won back to us a major industry and is engaged in grappling with problems of fundamental importance like marketing.

While on this point I cannot resist the temptation to refer to the outstanding achievements in the breeding of valuable crop types. Our most rapid and effective advance in agriculture has been along this line and to-day almost every crop is being systematically bred all over the country. Advance in this direction—*viz.*, the improvement of crop type and distribution of its seed—has been the most suitable to our present conditions of comparative poverty of resources in other directions. For the production of these types the resources in the way of plant material of more than one country has been and is being systematically employed. Combined with substantial Tariff protection afforded by a kind Government, it has resuscitated our sugar industry and thus saved a drain to the country of 15 crores of rupees per annum on the average. It is employing a hundred thousand additional labourers in the factories and about 1,500 graduates in these days of unemployment besides the five million extra agriculturists directly benefiting from it. This demonstrates the great value to the country as a whole of industries founded upon our own agricultural products.

That it is possible to augment the agricultural income of the villages to a considerable extent is evident from the fact that even in the West, which is much more advanced in this matter, the opinion is held that further marked advances are possible. A recent theoretical calculation has shown that, under the best of conditions and with the needed machinery and organization, twelve able-bodied men are sufficient to cultivate 365 acres of sugarcane and from it supply the carbohydrate needs of as many as 14,500 men and that thirty-five individuals could be fed from the produce of one acre, if properly handled. It is true that these calculations are somewhat theoretical as they assume conditions which do not exist and which it may be difficult to fully materialize, yet they are useful indicators of possibilities in the direction.

The evils resulting from sub-division and fragmentation of holdings have already been noticed. These are beyond the capacities of technical departments to remedy, however earnest or well organized they may be. They are caused by ideas and sentiments deep-seated in peoples' minds and legislation is the only remedy. It is a matter where we have to help ourselves and submit to certain hardships in the interests of the country as a whole. Other countries have shown the way. In Austria the economic holding is recognized by the law of the country and is both indivisible and unmortgageable (except for short periods). In Italy such holdings are said to be inalienable, indivisible and unseizable. In Denmark a law passed in 1837 provides for the proprietor leaving his farm intact to any one of his children and providing moderate consideration for his other heirs. It is gratifying that certain provinces have initiated action in this direction.

The Human Element.

Literacy and education.—As the efficiency of any programme of rural improvement depends primarily on the Chief Agent in it, the Villager, it is important to consider means for increasing his efficiency. If we compare the Villager with the Townsman one point in which the latter often scores over the villager is his literacy if not always his education. This is not the place nor is it necessary to detail the various advantages of education or even literacy. Suffice it to say that even in elementary education we have a very effective weapon for bringing the villager out of his narrow horizon, breaking down his superstitions, placing him in touch with the rest of the world through the printed word and for facilitating the introduction of various reforms for his betterment. In the progressive evolution of the human species acquisition of certain characters such as the 'erect habit' are credited with having introduced far-reaching effects. Education belongs to this category.

Though it is true that the village teacher did exist in the olden days and at least certain classes of the population received some kind of school and even higher education and though there is evidence that reputed universities did occasionally flourish in certain rural parts, regular schooling and education were not considered essential.

Education given in the village school should obviously possess the rural and agricultural outlook and be vitally linked with the every-day life of the village. In our boyhood days we learnt more about the geography and history of places we could never hope to see while being comparatively

ignorant of our own district and its environment. Such an important subject as the anatomy and physiology of the human body was reserved till the student had mastered the various distinguishing characteristics of the metals and the non-metals or the names of the then two important towns in the Sahara region. There is now a steady and welcome change in this matter. Nature study lessons fit in well the agricultural life of the villager and I have often wondered why the village vacations should be timed to the conveniences of metropolitan examinations rather than to the busiest agricultural seasons in the village when the boys could perhaps help their parents in the field and gain first-hand knowledge of subjects taught in the school-room.

Intellectual alertness.—A second characteristic of the Villager as contrasted with the Townsman is often the slower moving intellect of the former. This is not mentioned here in a derogatory spirit; the difference is due to difference in the environment. The every-day struggle with the great forces of nature develops a deeper character in the villager, but in intellectual alertness he is often inferior to the townsman. Agricultural operations are generally spread on the broad land and hence the workers are in comparative isolation, whereas intellectual alertness is greatly accelerated through contact and clash with other minds, a feature of industrial life. The rather extreme opinion has been held that most agricultural improvements themselves have been from men whose intellects have been sharpened by industries and commerce. The linking up of villages with towns and other villages, through better communication facilities, for instance, will remedy the situation.

Business habits.—Yet another common defect of the villager is the lack of so-called 'business' habits and 'business' mentality. This again is due to his environment and tradition. Nature's processes with which the Village Agriculturist is primarily concerned do not generally need the punctuality of the man of business or commerce. The cow is insured both in Denmark and Switzerland on account of its importance in rural economics. The absence of insurance measures in our villages against crop failures and cattle epidemics, which are by no means uncommon, is largely attributable to the absence of education and business outlook. The villager's income would be both enhanced and rendered steadier by the import of the 'business' mentality into his activities such as agriculture and cattle maintenance.

Outlook on life.—The villager's outlook on the world is often narrow because of the isolation and the absence of literacy. Whether he likes it or not, the villager is being dragged into the world currents of commerce and industry and his horizon needs to be broadened by education. His constant fight with forces of Nature over which he has little control, tinges his ideas with almost fatalism. A bad season too often disproves to him the truth in the saying 'As you sow so you reap'. Industrial activities, on the other hand, are associated with processes which demonstrate the control of natural forces by man and this has a tendency to develop in him certain amount of self-confidence, if not of human pride.

Cottage Industries.

In this study of the Indian village, the villager and village life, we have frequently noticed the need and advantages of industrializing the village. We have found that industries are desirable in the village to find employment for the people all through the year, to stabilize labour, to tone up the villager in various directions and to supplement and steady his income. The large-scale industries, which have developed in the country—while both useful and important for the progress of the country as a whole—have helped the villager but little. On the other hand, they have adversely affected the village tending to draw labour and brains away from the village. What is needed is the establishment of cottage industries in the village itself so as to improve the conditions for living in it.

It is obvious that the closer such industries are linked up with agriculture and agricultural products the better they would fit in with village economics. Cattle being an important adjunct of agriculture, industries like cattle breeding and production of milk and milk products at once suggest themselves. The value of cattle for agriculture is not confined merely to its use as labour, but the trend of recent work is indicative of their playing a very important part as the store house of the right type of manure for crops. The animal and plant kingdoms would appear to be the counterparts of one unit, each benefiting from the waste products of the other. Bee keeping, the poultry industry,

fruit growing and canning and preparation of tinned and infant foods for the benefit of the townsman would fit in well into the village.

Other suitable industries would be the partial preparation of manufactured products in the village itself as a rural industry. Cotton ginneries, seed decorticators and oil presses belong to this group. It saves in the transport of raw material to the central factory, the half-prepared material being generally less bulky than the original raw product. The retransport to the village of the bye-products of manufacture, such as seeds in the case of cotton which are needed back in the village both for sowing and as cattle food, is also thus avoided. Minor industries connected with products or articles available in the village or vicinity, such as cocoanut industry in the West Coast and fish curing in seashore villages, help to keep the villages prosperous.

Other handicrafts and domestic industries, where the needed material is imported from outside and worked in the village during the off-seasons, include weaving, dyeing and the manufacture of toys and trinkets. In spite of technical advances there are yet certain industries which lend themselves to be worked in the villages as domestic industries. The manufacture of toys in the Black Forest regions of Germany, watches in Switzerland, cutlery in Sheffield and little fans, flower baskets and ornamental pieces in Japan are of this class and are a great help in supplementing and steadying the villager's income. The mechanical efficiency obtained in the village as the result of such rural industries gives the village a 'mistry' class who should prove increasingly useful in the repairs and upkeep of farm machinery and water lifting pumps which are spreading in the country.

Co-operative Organization.

The value of organizing on a large scale for increasing efficiency is well known and widely accepted. Most village activities, on the other hand, have by their very nature to be on the small scale and their being grouped together through co-operative organizations is the only remedy. Through them even the small farmer and producer is enabled to command facilities and advantages generally available only to large-scale units. The purchase and sale of articles connected with cottage industries, for instance, need grouping together through co-operative organizations for best results.

Amenities of Life.

As a class our villages lack the conveniences and amenities of urban life. While perhaps certain of these might be considered unnecessary and a few even harmful, there can be no doubt that the bulk of them are in tune with and are necessary for modern progress which is taking hold of the world whether we like it or not. Conveniences like means for rapid transport, the Post and Telegraph, the newspaper and the ever-increasing improvements associated with the development of electricity are major blessings which it is desirable should be extended to the villages as quickly and as completely as possible. It is the absence of these in our countryside that is partly responsible for the prevailing distaste to village life. The village is easily healthier than the town in such important factors as pure air and open spaces and if only certain urban facilities are implanted in the village, its attractions for settlement should prove irresistible.

For permanent results the urge for rural improvement should be implanted in the village itself. This could be achieved only by improving the chief natural agent in such work—*viz.*, the Villager—and making it attractive for him to live and have his being in the village itself. Endeavours that are town centred and take to the village for temporary periods, for lectures, demonstrations or shows—however honest or energetic—have an outside flavour to the villager and do not, therefore, get permanently assimilated into village life.

CONCLUSION.

To sum up, there is little doubt that the villages of old were more populated than they are to-day largely because of conditions prevalent at the time. Those conditions will never return however much or sincerely we may hanker after them. The town and the characteristics associated with urban life are definite products in the march of events and need to be accepted as such. Though there are drawbacks associated with urban life the town has its own good points which need extension into the village to keep rural life in tune with the changes around us. At the same time, the countryside has advantages like open spaces and absence of congestion which can never be reproduced in the town.

Life activities that were village centred in the past are increasingly getting town centred to the disadvantage of the former,

In the interests of the country as a whole relationship of mutual help needs to be established between the two. The town should extend to the village its greater knowledge, quicker living and the manifold amenities of the modern age. Contributions from the countryside are of equal importance. It alone can produce the raw materials of commerce and industry and thus help in the growth of towns and cities. It alone can supply adequate and wholesome food to the millions of our land whether resident in the village or town. Lastly, the countryside alone can imbue the urban 'business' civilization with the deeper character and larger humanities which are nurtured in the villager through his more direct and constant contact with the great forces of Nature and of life. Our duty then is clear: Namely, to improve the *Village*, the nucleus of our country life, and infect its Chief Agent, the *Villager*, with a chosen culture of the virus of modern age through *Education* and *Industrialization*.

Summaries of Addresses of Presidents of Sections.

MATHEMATICS AND PHYSICS.

President: DR. S. DATTA, D.SC., F.N.I.

ON ABSORPTION OF LIGHT BY ATOMS AND MOLECULES.

ABSORPTION of light by atoms and molecules formed the subject-matter of the Presidential Address by Dr. S. Datta.

He related how the main facts of absorption not only by normal atoms but also by those excited by thermal, electrical or optical stimulus, have all been accounted for by the simple Bohr theory together with the modified selection rules for inter-orbital transitions and the Boltzmann distribution giving the concentration of atoms in the various excited states. Quantum theory is however unable to explain the facts relating to the intensity of absorption lines and this is accomplished by the wave-theory and in a more satisfactory manner by the recent theory of radiation proposed by Dirac.

He next dwelt on the question of the fate of the absorbed energy and indicated the various ways in which the absorbed energy appears to be dissipated according to the facts of observation.

The width of absorption lines formed the next point of his address and he gave the outline of the modern theories of both natural width and its broadening due to pressure.

He next drew attention to the fact that a division of the energy of the photon which follows from the laws of conservation when applied to the processes of exchange of energy between photon and matter is irreconcilable with the phenomenon of discrete absorption according to which the photon energy is indivisible. A mechanism by which Compton effect could be explained without dividing the quant has been suggested.

Dealing with absorption by molecules he discussed the main features of absorption by various types of molecules and suggested that the presence of more than one continuous absorption maximum unaccompanied with bands may as a rule be taken as the chief criterion of an ionic molecule composed of singly ionised atoms and banded absorption with or without continuous absorption those of atomic molecules both polar and non-polar. He then discussed the possibilities of obtaining absorption bands with ionic molecules consisting of doubly ionised atoms and of continuous absorption unaccompanied with bands by atomic molecules, as also the band spectra given by Van-der-waal molecules.

Measurement of the heat of dissociation of molecules from a knowledge of the classifications of the different progressions in the cases of molecules giving banded absorption and from a knowledge of the long wave-length limit in the case of molecules giving continuous absorption were next discussed. In the latter case the use of micro-photograph for finding the limit was strongly recommended. Suggestions were given for the best method of preparing the spectrogram for micro-photographic analysis.

Careful analysis of the continuous absorption records show the presence of several maxima towards the long wave-length limit as first observed by Sommermayer in the cases of alkali-halides. The author's own observations relating to HCl, HBr and NO seemed to confirm the phenomenon and justify the interpretation that the interval between the maxima correspond to the fundamental vibration frequency.

After referring to the phenomenon of pre-dissociation and colours of inorganic salts Datta concluded his valuable survey by indicating some of the important rôles which absorption experiments have played in pure physics as also in industrial and medical problems.

CHEMISTRY.

President: PROF. J. N. RAY, PH.D., D.SC., F.I.C., F.N.I.

THE CHEMISTRY OF ANTIMALARIALS.

APART from the terrible toll malaria takes annually in the form of human life, its influence on labour inefficiency is a serious factor in the industrial development of the country. In the address the author gives an account of the recent developments in the prevention and cure of malaria by chemicals, in which he and his co-workers have taken an active part.

The relation between chemical constitution and physiological action has a significance in the discovery of new drugs similar to the relation between chemical constitution and colour in the discovery of new dyes. The slow growth of the science of chemotherapy is due to the fact that physiological action has no simple meaning, but covers every action a chemical may exert on the living organism. However, in recent years

considerable progress has been made as evinced by the preparation of new antimalarials and other medicaments.

The physiological action of quinine may be located in (*a*) the quinoline ring, (*b*) the quinoclidine ring, (*c*) the vinyl group. That cinchonine is less effective against malaria than quinine can be explained as due to the difference of solubility of the drugs in erythrocytes, caused by the presence of methoxy group in one. If the ether chain is increased, an improvement occurs as in ethoxy-cinchonine but further lengthening of the chain decreases antimalarial action. Hydrogenation of the vinyl group increases antimalarial action but mere hydrogenation does not produce any antimalarial activity where none is present in the original unsaturated compound. It appears, therefore, that the vinyl group is not directly concerned with the antimalarial action of quinine, though the destruction of the vinyl group and its replacement by a carboxyl group results in total loss of activity, which is regenerated on esterification. Stereoisomerism around the secondary alcoholic group has no material influence on the antimalarial properties of quinine but the replacement of the hydroxyl group by halogen, etc., results in the loss of activity.

From the foregoing summary it would appear that the seat of antimalarial action of quinine is in the quinoline nucleus and that it is augmented by the presence of a secondary alcoholic group. Of the different quinoline derivatives synthesised in recent years, plasmoquine and the Russian product 'plasmocide' have been most successful. Both are gametocidal but have little action on the schizontes. The researches of Fourneau, Robinson and others show that, in compounds of the plasmoquine type with an amino alkylamino group in position 8, greater activity is displayed when the alkyl of the latter group is a straight chain than when it is branched, and that the alkoxy group in position 6 is not indispensable but is always favourable to antimalarial action. The quinine-plasmoquine treatment has been tried on a large scale by the Bengal Government and it appears that it is definitely beneficial.

Mietsch and Mauss have prepared various alkylamino-acridine derivatives of which the substance 'atebrin' has been found to be most valuable. It is less toxic than plasmoquine, from which it differs in that it does not affect the gametes but kills the schizont forms. Thus, it is complementary to plasmoquine. Atebrin used alone is quite sufficient to eradicate the asexual forms of the parasite and hence can effect a clinical cure of malaria. A drug having true prophylactic effect must possess a specific action on the sporozites. Neither plasmoquine nor atebrin, however, possesses this action. A drug having true prophylactic effect has yet to be discovered.

In recent years, an ideal antimalarial has been sought in quinolino-pyrrols by Mrs. Robinson, in glyoxalinoquinolines by Ray and his co-workers. Harmaline has been found to have some curative value in malaria. Ray and his co-workers have prepared pyrryl indoles with partial similarity to the harmine structure. Although the experiments have not yielded positive results, still some purpose has been served in that certain apparently reasonable postulates have been investigated and eliminated. The work of Robinson, Brahmachari and Das Gupta, Chatterji, Seshadri, Kermack, Clemo and others have all been helpful in this respect.

Opium was considered to have a prophylactic value in malaria. This possibility has been investigated and the work so far done, to find a suitable antimalarial amongst the derivatives of narcotine and cotarnine, indicates that it is very unlikely that a potent antimalarial will be found in this series.

Sharp has investigated the alkaloids of *Alstonia* but found both echitamine and alstonine to be valueless.

The recent use of salvarsan, stovarsol and mercuro-chrome in benign tertian malaria suggests that the study of organo-metallic compounds should yield profitable results.

In his address the author has given an account of the recent development of the chemistry of antimalarials and has indicated the possible lines of investigation, which should stimulate further research in this important branch of chemistry. For the treatment of the malaria-stricken masses of the world, a drug is required which is cheap, very efficient and safe. Nothing so far known meets all requirements but the development of active synthetic compounds augurs well for the future and clearly points to the possibility of still better ones being discovered.

The address concludes with an appeal for funds for financing research in the universities. It is hoped that the public will be inspired by the noble examples set by the late Sir T. N. Palit, the late Sir R. B. Ghosh, Sir P. C. Ray and others.

GEOLOGY AND GEOGRAPHY.

President: W. D. West, M.A. (Cantab.), F.N.I.

EARTHQUAKES IN INDIA.

THE foundations of the scientific study of earthquakes in India were laid by Dr. T. Oldham and his son R. D. Oldham. The latter will best be remembered for his great memoir on the Assam earthquake of 1897, and for his discovery of the three main types of earthquake waves that are recorded on the seismograph, a discovery that has proved most fruitful in investigations regarding the internal structure of the earth.

The occurrence of earthquakes in India is a legacy of the great earth movements that convulsed the northern flanks of India during Tertiary and Quaternary times, throwing up the Himalayas and the Baluchistan and Burmese mountains. For this reason earthquakes are confined in their distribution to these mountain ranges and to the plains immediately bordering them. By comparison Peninsular India is an area of comparative safety, in which only minor shocks occur.

A detailed analysis of the geological structure of the earthquake belt provides an explanation of the origin of most of the earthquakes occurring within it. In Cutch the subsidence of the coastal tracts beneath the sea is probably the cause of earthquakes in this area. In Baluchistan the re-entrant angle in the alignment of the hills by Quetta and Sibi must be an area of

special strain, and earthquakes are concentrated around it. In Northern India earthquakes probably originate in movement along one of the many thrust faults that have developed as a result of the southward advance of the Himalayan range. In Assam the Assam range, a fragment of Peninsular India, is caught between the converging earth waves from the north and from the east, and has become rent by fault fractures, which are the cause of the earthquakes. Finally, in Burma most earthquakes have been located on one or the other side of the central Tertiary belt, a sunken trough or synclinorium bounded by zones of faulting on either side.

During the present century earthquakes have been confined in the main to three centres of activity—Baluchistan, Assam and Burma—with an occasional disastrous earthquake elsewhere within the danger zone. The Assam earthquake of 1897 was probably the most severe that has occurred anywhere within historic times, though the loss of life was small. But the Kangra earthquake of 1905, the North Bihar earthquake of 1934 and the Quetta earthquake of 1935 between them accounted for at least 60,000 lives.

This disease of earthquakes is a chronic one, but is not peculiar to India. Other countries that suffer from it, such as Japan, California, New Zealand and Italy, have taken steps to combat it, but in India practically nothing has so far been done. It is strongly recommended that a seismological branch of one of the existing services be started, and that research be conducted similar to that done in Japan. The cost of such a branch would be trivial in comparison to the many crores of rupees worth of damage done by a big eqarthuake. In addition, endeavours should be made to imporve the standard of building within the earthquake belt. The value of simple earthquake-proof construction in saving both life and property was clearly demosntrated during the Quetta earthquake. A simple building code should be drawn up by which new construction and town planning in the more important cities of India could be controlled. In addition, more detailed codes should be drawn up in accordance with local needs, and enforced by Provincial Governments and Local Boards.

BOTANY.

President: H. G. Champion, M.A., F.N.I.

THE NEED FOR SCIENTIFIC STUDY OF INDIA'S CLIMAX VEGETATION.

Forest growth still covers about one-quarter of the land surface of India, and if it were not for human settlements and forest-destroying activities, it would undoubtedly cover the whole country with the exception of the excessively dry north-east portions, a few dry tracts in other parts, and the relatively limited alpine areas in the Himalayas which are too high, cold and exposed for it.

It might accordingly be expected that trees both individually and collectively would form the subject of much botanical study in this country which has seen the oldest civilisation in the tropics and is still much the most highly developed tropical country. Even in temperate western countries, very little is yet known about the physiology of the individual tree and still less of the physiology of tree crops, and the life history and problems of the tropical forest are still almost unexplored. In the absence of the needed information, there is a rather dangerous tendency to apply what is known or believed to hold for the temperate forest without proof that such application is permissible.

The interesting problem of the method by which water is lifted to the top of even the tallest trees is almost the only one which has so far attracted much attention. Studies of light quality and intensity under different types of tree canopy and the reactions of the ground vegetation and the regeneration of the overwood trees to variations in these factors are much needed. The absolute water requirements of tree crops in relation to the demands of other types of soil cover are of importance in all irrigated and dry tracts, and call for investigation. Further wide fields for study are offered by problems connected with the secretion of resins, dammars, gums and oils: also those connected with genetical and distribution problems.

Only small beginnings have been made of the study of the tropical forest in relation to the soil, though the great importance of a forest cover especially in the tropics is now generally realised. In its rôle of the great contributor of humus to the soil, it is of the deepest significance to the agriculturist and indeed all humanity, but we still have extremely little precise information on the subject. This reaction of forest on soil is reflected in the succession of forest types which follow one another on new soils which have been and are being laid down by river action and in other ways, providing a most interesting and important field for ecological studies. The professional forester is well aware of the occurrence of such successions but the trained research worker is required to study them in full scientific detail.

The consequences of the maltreatment and gradual opening out or destruction of the forest cover provide the reverse aspect of ecological succession towards the climax vegetation. Such retrogression in many parts of India has gone far beyond mere botanical interest to become an economic problem of first rank importance. Realisation is now rapidly spreading of the causal connection between denudation of forest cover in the hilly tracts and the loss of fertile soil on the slopes by erosion, the overwhelming of valuable agricultural land at the foot of the hills by sand, gravel, and boulders brought down by torrents themselves generated by the loss of the absorbent forest and soil cover,....and also the occurrence of disastrous floods in the plains.

The scientific study of trees and crops calls for a special technique both in the collection and the analysis of data. This is mainly due to the large size of the individual and the space it occupies, and the slowness of its development to maturity and subsequent decay, but complications also ensue from exposure to all kinds of influences, mostly injurious ones from which agricultural crops are more or less protected.

India is in a unique and very favourable position to lead the world in the study of the tropical forest, the problems awaiting solution being full of interest to the scientific worker, and full of importance on their economic side.

ZOOLOGY.

President: GOBIND SINGH THAPAR, M.SC., PH.D.

HELMINTHOLOGICAL RESEARCH IN INDIA.

DR. G. S. THAPAR, in his Presidential Address on the "needs and opportunities of Helminthological Research in India" emphasizes the importance of helminthology in medicine, public health, veterinary science and agriculture. He pointed out the indifference with which this science was studied in India, but in recent years there would seem to be a growing appreciation, both by the Government and the Universities, of its importance. The recognition of the work of professional zoologists in India in this connection seems to be a healthy sign, as the past records in other countries reveal the solution of many fundamental problems of helminthology at the hands of the zoologists.

It is true that refinements in sanitation are helpful in the eradication of human parasites: in fact "*Tænia solium* is said to have taken a road to extinction when the mythical Chinaman burned down his house, ate the incinerated pig and pronounced that it was good." But there are great many difficulties in the control of helminths of domestic animals. Limited sanitation, over-population of farm animals, due to greater utilisation of land for agriculture and human habitation, varied means of transportation and climatic factors—all help to increase helminthic infection of the domestic animals. It is, therefore, necessary that investigations should be undertaken on an extensive scale on such problems in an agricultural country like India.

Referring to the ancient history of the subject in India, Dr. Thapar drew attention to the references found in Sûsruta, Charaka and Madhava Nidhana and from these he has identified such worms as *Dvimukha* and *Parisarpa* as *Enterobius vermicularis* and *Microfilariæ* respectively under the modern scheme of nomenclature. But very little progress seems to have been made on the subject in ancient India and the doctrine of Ahimsa seems to have played its part in this direction.

Much of the recent information on worms in India is due, chiefly, to the valuable work of certain enthusiastic officers of medical and veterinary services, who, in the course of their routine work, were confronted with worms and this formed the basis of our knowledge of the subject.

Unfortunately, there are great difficulties in providing adequate knowledge of helminthology for our students in India, though the Text-Books in Zoology claim to have been revised and brought uptodate, they still contain old and antiquated nomenclature and classification and these instances are enumerated. Some of these text-books give a confused account of the life histories of even the common worms, like *Ascaris*. This leads to a serious handicap in the treatment and application of preventive measures.

Further, it is desirable to avoid imparting an anthropomorphic outlook of helminthology to the students of zoology, as, in this, the students generally lose all interest in the subject for the rest of their career. A student should study the subject in order to explain the phenomenon of parasitism and for this he should collect helminths from his own dissection animals.

In suggesting the scope of work, Dr. Thapar says that there is considerable field for investigation in the morphology of the worms, as helminth fauna of India still remains unexplored. Even the re-investigation of the described forms seems to offer ample scope of work, as errors in diagnosis are perpetuated in the recent literature on the subject. Illustrations are given from the work of various authors to show the justification of re-investigation of even the described forms. The chief problem in helminth morphology today is the elimination of errors which unfortunately have crept into the earlier literature.

The accurate morphology and natural classification would answer the problems of relationship and evolution of the group and numerous illustrations cited have been collected from the work of Dr. Thapar and his colleagues at Lucknow.

The solution of life histories will greatly facilitate the control measures and Leiper's work on the Schistomiasis in Egypt amply justifies further work on similar lines. The recent discovery of *Echinococcus* cysts at Lucknow simulating *cœnurus* cysts seems interesting and promises fresh fields for experimental investigations.

The question of host specificity is also discussed and conflicting observations by prominent workers are indicated to show the necessity of further investigations on the subject. The question does not seem to be a settled one.

Considering the pathogenic effects of helminths, Dr. Thapar made references to the recent demonstration of *Enterobius vermicularis* as a cause of appendicitis in man and this has awakened interest for the study of the diseased condition, particularly in animals. The discovery of *Schistosoma spindalis* as a cause of "Nasal granuloma" of cattle, commonly known as snoring disease in India and the recent investigations on the etiology of "Barsati" of equines, showing *Habronema* larvæ in the affected parts of the animal's body are illustrations to indicate worms as cause of disease in animals. Both these animal diseases were believed to be of mycotic origin and these discoveries mark a new era in the disease investigation of animals in India.

There are a large number of anthelmintics used for the removal of worms but a considerably larger number prescribed by Hakims and Vaids, claim specificity for particular kinds of worms. Chopra has investigated many of these indigenous drugs for their action but a majority of them still need verification. The crude method of administration of certain plant products, like the juices of *Blumea lacera* (kukronda) as local application and otherwise against the common pinworm of man by laymen offer fresh field in the study of drug administration in their natural condition, particularly for the domestic animals. The effect of yeast and vitamins on the immunity problems forms a necessary adjunct to such investigations, as it would be desirable to obtain parasite-resisting strains of animal population that would be better fitted in the struggle for existence.

The production of pearls inside the molluscan

shells is said to be due to the presence of helminth larvæ and for this, growth of such larvæ may be encouraged. This is an aspect of helminthology that demonstrates its utility to man.

In view of such opportunities of varied nature offered by the study of helminthology in India, and its growing significance in different spheres, emphasis must be laid on the necessity of co-operation amongst workers in different fields—medical, veterinary, public health and agriculture—so that we may be better able to combat the problems and obtain most satisfactory results. The experience of such a work in other countries amply justifies such a line of action in India. Let us, therefore, stimulate interest in the study of helminthology, so that by patient interest and diligent application we may help in the solution of various problems connected with helminthological research and thus establish an active school of helminthology in India.

ANTHROPOLOGY.

President: DEWAN BAHADUR L. K. ANANTHA KRISHNA IYER, B.A., L.T., M.D. HONS. (Bres.).

AN ETHNOGRAPHICAL STUDY OF THE COORGS.

DEWAN BAHADUR DR. L. K. ANANTHA KRISHNA IYER reviewed the progress of anthropology during the past 24 years in his Presidential Address.

The principal subject of his address was an ethnographic study of the Coorgs. The writers who had made an intensive study of the Coorgs differ in their conclusions, and Coorg inscriptions throw very little light on the early history of that interesting community. The province was successively connected with the Kadambas, Ganga Dynasty, Hoysala kings, Nayaks of Belur under Vijayanagara rulers, the Lingayat rajas of Coorg as also those of the Bednore family. Further the Coorg rajas were themselves aliens. Wynad Chetties have their settlements in Coorg as their house names testify. From all these facts it is conjectured that the Coorgs are not without a racial admixture from a remote period. There is also a great deal of culture contact between the Coorgs and the people of Malabar, Canara and the Tamil districts, and the Tulu population. Their language is a mixture of the Dravidian languages. The physical traits are biologically useful, and related to mental capacity and intellectual endowment. Applying this maxim to the Coorgs, their mountain habitat, climate, food and occupation have largely made them what they are at present. It is interesting to note that these factors have differentiated them from the people of the plains.

Dr. Iyer next dealt with the economic life of the Coorgs who were first hunters and fishers, and then agriculturists. Their hunting propensities are still seen in their festivals, and their primitive weapons are being gradually replaced by modern guns and spears. Fishing is generally carried on in streams and paddy fields during the rainy months. Agriculture of the Coorgs which is of the rudest kind, is similar to that which prevails in other parts of India. It is a system of rural economy formed at a remote period and transmitted for ages unchanged. The cultivator is attached to the ancient practices, and views with dislike any attempts at innovation. Industry of the people of the highlands is confined exclusively to the cultivation of rice. The narrow valleys between two high grounds are very productive. The agricultural implements are few and of the rudest kind, and yet the yield has furnished an unfailing supply from ancient times both for consumption and export to Malabar. Wherever possible, the valleys have been formed into flat terraces for cultivation.

The agricultural year, as in other parts of South India, begins about the middle of April, *Chaitra Sankranti*. With the first shower in April or May, the ploughing commences. On an auspicious day before sunrise the house lamp which plays a conspicuous rôle on all festive occasions, is lighted in the inner verandah when the members of the family assemble and invoke the blessings of their ancestors and Cauvery Amman (River Deity). The young men make obeisance to their elders, and drive a pair of bullocks to the paddy fields. The landlord now offers cocoanuts and plantains, rice and milk to the presiding deity of the *nad* (division of the district) lifting up his hands to the rising sun, and invoking his blessing. The oxen are yoked and three furrows are ploughed when the work is finished for the morning. Of the upturned earth, he takes a clod to the store house or granary, offers his prayers to Siva to grant him an increase of one hundred times. From 6 to 10 A.M. the ploughing continues till the fields are turned two or three times. Then the borders are trimmed, and the little banks repaired to regulate water. After this, sowing, transplanting, weeding, and finally harvesting are in operation. Before the completion of transplantation of the largest field, an open space of 10 feet wide is left throughout the whole length, to provide the Coorg race-ground offering a jolly good sport amidst their monotonous work.

To a large number of Coorgs, cultivation of coffee, cardamoms and fruits are important industries. The Coorgs are fond of honey gathering. It is a domestic industry. The Coorgs have an abundant supply of food materials. They rear pigs and goats. Their chief article of diet is rice and on festive occasions cakes and sweetmeats are also prepared. The Coorg hospitality is proverbial. The Coorg houses like those of the Nayars are generally situated close to their paddy fields on a sheltering slope of Bene land surrounded by columns of plantain trees, sago palm, betelnut palms, orange, jack and gauva trees. A coffee and a small kitchen garden are seldom absent. In the compounds of some houses there is a small pond well stocked with fish. The buildings very much resemble those of the Nayars of Malabar and the approaches of the old Coorg house mark the design of fortification. The tradition points back to the time of general feuds when chief fought with chief and clan with clan. Deep kadangas or trenches with high embankments still testify to the memorials of their warlike state of affairs in former times. The furniture of a Coorg house bear ample testimony to the simple habits of the inmates. The Coorgs are a hardy race and bear with fortitude much hardship especially during the monsoon months when they are engaged in cultivation. Exposed to all the inclemencies of the weather they retain their vigour, most admirably. Their

dress and ornaments are peculiar. Their marriage regulations are a curious medley of old and new rites, fashions and notions. In former times their marriage festivities had a communal character. Marriage is adult and has some of the formalities of the Hindu ceremonies. The Coorg family is joint and patriarchal. There is not a single family affair of any importance which may not be undertaken without the consent or knowledge of the senior member. The senior female member is the queen of the household. Their public morality is controlled by a council of elders, and they are the moral censors and managers of all social matters without any material help from the Government. The offenders are punished with fine or excommunication. The Coorgs are animists and have their ancestor and demon worship. They have been influenced by the Malayali, Tulu, and recently by Canarese Brahmanical and Lingayat superstitions. The Tulus have introduced their demons and ancestors worship, and their services are often requisitioned. They worship *Cauvery Amman*, and their chief festivals are *Huttari* corresponding to the *Onam* festival of Malabar and Kaylmurta.

AGRICULTURE.

President: Rao Bahadur B. Viswa Nath, F.I.C., F.N.I.

SCIENCE AND PRACTICE OF AGRICULTURE IN INDIA.

Rao Bahadur B. Viswa Nath, Imperial Agricultural Chemist and Officiating Director, Imperial Agricultural Research Institute, New Delhi, presiding over the Agricultural Section of the Indian Science Congress, spoke on "Science and Practice of Agriculture in India". He reviewed the progress of agricultural research in India with reference to agricultural practices in the country, and directed attention to some important problems. The address is, in the main, an analysis and synthesis of the existing data from the laboratory and the field, which leads to the important issue, namely, the building up of the soil. He said that Indian soils and agricultural practices were several centuries old and that research should and was concerning itself more with the details of existing practices than with the evolution of wholly new methods, whose success was doubtful. and said that the aim of research was to build up on the existing system a state of agricultural practices suited to the conditions of the soil and the resources of the cultivator, who was always ready to take up any improvement suited to the conditions with which he was faced.

Speaking of the work on soils, Mr. Viswa Nath said that the aim was to maintain the high productivity of the soils that were already rich, to restore to normal, those soils whose productive capacity was impaired, and to increase the yield of soils which were originally poor. He referred to the scientific studies directed to the attainment of these objects, discussed the important differences between Indian and European soils, explained the lack of success, in India, in the application of many of the results and practices found suitable in those countries and stressed on the necessity for a different outlook on the applied aspects of soil science particularly with reference to arid and semi-arid soils of the country.

The Rao Bahadur then discussed the work on manures and fertilisers during the past quarter of a century and said that the evidence clearly established the importance and suitability of organic manures to Indian soils. In regard to fertilisers, he said that the theoretical possibilities of artificial fertilisers were almost limitless but that their achievement on Indian soils was limited by the organic matter supply to the soil and pointed out the necessity for husbanding our resources of organic manures and for utilising them to the fullest extent possible. He drew pointed attention to the evil consequences of intensive cultivation and the intensive use of fertilisers without the necessary accompaniment —namely organic matter and organic manures. Organic matter was the life of the soil and if organic manures were neglected we should be doing four things. Firstly, the fertility of the soil would not be maintained, secondly, artificial fertilisers would not be used to the fullest advantage, thirdly, the cropping power of the improved seed would be reduced and fourthly, the nutritive value of food crops would be low.

Rao Bahadur Viswa Nath finally referred to problems of food and nutrition and discussed the problem both from the point of view of quality and quantity and said that in both these directions soil conditions played a prominent part. He referred to his own work and that of McCarrison on the subject and said that manuring contributed to the nutritive value of the crop and in this respect organic manures were the best in endowing a crop with a high nutritive value. In regard to quantity, the Rao Bahadur showed by calculations that our present production of food crops was enough for the proper feeding of only two-thirds of the population and that there were considerable scope and possibilities for increasing production. This he said depended on the building up of the fertility of the soil and pointed out in the address the ways and means of doing it.

PHYSIOLOGY.

President: Lt.-Col. S. L. Bhatia, M.C., M.A., M.D., F.R.C.P., F.R.S.E., I.M.S.

PHYSIOLOGY IN INDIA.

In India as elsewhere, the history and growth of Physiology were inseparably connected with those of Medicine. Medicine had been practised and taught in India from times immemorial. The system of Medicine indigenous to the soil was the Ayurvedic. Subsequently the Unani or the Greaco-Arabian system was introduced, which had developed under the enlightened patronage of the Khalifas of Baghdad. Then he described the steps that led to the introduction of Modern Medicine and Physiology into India. This movement started in the early part of the nineteenth century. At this time, instruction in Ayurvedic and Unani Systems of Medicine was imparted in the Sanskrit College and Madrassa in Calcutta. In 1822 the first Medical School was established in that City. A similar Medical School was established in Bombay in 1826, but after functioning for six

years was abolished in 1832. It was to Lord William Bentinck, the Governor-General, that the credit was largely due for initiating higher medical education in India. For improving the Medical School in Calcutta, he appointed a Committee in 1833 whose deliberations have had a most profound effect on the future course of Medical Education in India. Lt.-Colonel Bhatia then briefly described the origin of the Medical Colleges in Calcutta, Madras and the Grant Medical College, Bombay, the three oldest Medical Colleges in India, where the teaching of Modern Medicine and Physiology first started. Subsequently numerous other Medical Colleges and Schools were established. With the increase in the number of these institutions there resulted a marked expansion of Medical education. And side by side with this, the knowledge of Physiology also spread.

Physiology in Europe.—In order to furnish a correct perspective to the position of Physiology in India, Lt.-Col. Bhatia made a rapid survey of its development in Europe and especially Great Britain.

Physiology in India: The Future—Physiology had a brilliant future in India. There were many problems in the solution of which the guidance and help of the Physiologist were indispensable.

(*a*) *Physiology and Social Service.*—Laboratory Physiology is not an end in itself, but a means by which we can understand the larger problems of life, and specially human life on this earth. It was a melancholy fact that in proportion to the knowledge of Physics and Chemistry the knowledge of Biological Sciences in the country was comparatively meagre. And yet in considering ways and means to bring about social reconstruction, and physical well-being of the people, a knowledge of Physiology was indispensable.

(*b*) *Nutrition.*—The subject of bodily nutrition was the special domain of the Physiologist. During the last 25 years or so, very important investigations had been carried out, in the field of the qualitative side of dietetics, specially the biological value of different proteins of animal and vegetable origin, and of the special significance of the mineral constituents of the diet and vitamins. The subject of nutrition in India needed to be investigated from many points of view. To the Physiologist it offered great opportunities for original research work. He trusted that many workers would be attracted by it, for, the knowledge thus gained would be of direct benefit to our countrymen.

(*c*) *Racial and Anthropological Physiology.*—There was a tendency amongst workers in India to investigate normal physiological constants. This information was of the utmost value, as it would indicate any differences that might exist when compared with data from European countries. It would throw light on any racial or environmental variations that may occur. We should thus have a basis for Racial or Anthropological Physiology, an important branch of Human Physiology, which had not received sufficient attention hitherto.

(*d*) *Adaptation to Tropical Climate.*—Another fruitful line of physiological investigation was to ascertain the factors concerned in the adaptation to tropical conditions. Undoubtedly here, as elsewhere, the famous dictum of Claude Ber 'La Fixite du Milieu interieur est la conditio la vie libre' held good. These were some of ι... problems jotted down at random that could be taken up for investigation.

Physiology in the Medical Curriculum.—In the pre-clinical group of subjects Physiology occupied a position of the first rank. There had been a great deal of discussion in recent years in England and elsewhere regarding the scope and function of this pre-clinical instruction. The wide gulf that separates the pre-clinical and clinical sciences should be bridged and there should be continuity of instruction in pre-clinical sciences in the clinical years.

Concluding Remarks.—In order to escape from empiricism and legitimately to claim the status and dignity of a science, Medicine must have Physiology as its basis. But Physiology had other aims of its own. Some of the greatest discoveries in Physiology in recent years had been made by men who had no medical training whatever. It had flourished most in those Universities where it had led an independent existence like Physics and Chemistry. Although the ultimate aim of all Sciences is the welfare of mankind—and this is perhaps true more of Physiology than any other science—the immediate aim of any scientific endeavour must be the discovery of *truth*, irrespective of its possible applications.

In conclusion, Lt.-Colonel Bhatia said that the two greatest needs of the hour in the scientific world in India were to have more scientific workers of first class ability, and to have harmony and good-will amongst them. Gatherings such as these, apart from promoting scientific discussions and advancement of Science brought about unity and friendship amongst the workers. They established such contacts as were not possible in any other way. He hoped that the section of Physiology would promote solidarity and cordial relations amongst all the Physiologists in India. Thus, Physiology will make a great headway, and its progress will be a pride to us all. 'Let us, therefore, march forward and fulfil our mission of serving Physiology with faith, hope and charity, with faith in the ultimate benign aim of our science, with hope which will strengthen all our efforts, and with charity in which as men of science to be worthy of our vocation, we must live, move and have our being.'

PSYCHOLOGY.

President: K. C. Mukherji, M.A.

THE SOCIAL MIND OF THE INDIVIDUAL.

Social relations are essentially mental. In the individual's mental life some one else is invariably involved. There are not at first individuals and then a social unity, as there might be bricks and then a pile of them.

Some believe that collective consciousness is the highest form of psychic life, and society is the real god. Any alleged superiority of social mind can hardly as a rule be maintained. If a wave of emotional agitation sweeps through the group each may become less than himself, less critical and more suggestible. There is a

considerable tendency to change one's opinion as a result of discussion, but it is experimentally observed that the females profit more by this discussion than the males. We observe practically that the number of jurors is increased to decide cases of murder while to keep the look-out for the safety of the ship only one man, and not ten, is employed. The weight of responsibility is divided among the members of the group and weakened in proportion for each man. But for this diminution of this sense of responsibility man can hardly condemn another to death. The group or committed decision is sometimes altogether irresponsible and may only be an intellectual necessity to avoid the crushing weight of high individual responsibility.

Social consciousness follows almost a cyclic order of development. The individual is more a social outcome than a social unit. The child is not an individual when he enters into the society but he grows into an individual by social interaction. The outline of the individual gradually appears, and at every stage it shows the pattern of the social culture of which he becomes a specification. The social culture in the last analysis comes from the individuals themselves. So individuals should be not merely static conformists to, but creative artists of culture. A non-creative personality or a culturally passive mass is a failure, educational as well as social. So the political or legal organisation should have only secondary value as existing for the sake of cultural institution and activity.

The consciousness of the family group prepares the child's mind for and accentuates the development of wider group sentiment. The family sentiment and the national sentiment are equally strong in Scotchmen especially the Highlanders. The family sentiment is very keen among the Japanese who are also noted for their high national spirit. This is also true of Germany and Italy. The people of East Bengal are noted for their national outbursts, but their sentiment for joint family system is also highly remarkable. Although any vital connection can hardly be established in view of the low sense of nationality possessed by primitive people in spite of intense family sentiment, but still the importance of the mental effects of the family life in relation to the foundation of national sentiment should be no less insisted on than the importance of the organisation of the family life for the material welfare of the State, and it is probably true that any barrack system of rearing up State children, if introduced, would be disastrous to the growth of national life. There is no reason to find in the family a natural menace to the development of wider social feeling. Unless narcissistically fixated and concentrated the family sentiments aid rather than impede the development of higher social sentiments.

Peoples are greatly moulded by their physical environment. In India the astounding magnitude of the objects and the appalling character of the devastating forces of nature stimulated the uncritical minds of the people into grotesque fancies which probably led them to portray gods with many arms, three eyes and terrible visages.

There is some evidence that the crossing of closely allied stocks does conduce to increase of vigour and energy of mind and body and also to the variability of the stock for the production of persons of exceptional gifts. The Chinese have a high average ability and are a relatively pure race but their culture has stagnated for want of men of exceptional capacity. So the rigour of the exclusive caste system for the maintenance of the purity of blood is not biologically sound. But the crossing of the widely different stocks is supposed to produce an inferior race. So the Eurasians of India are said to be of a comparatively poor race. But any universal characterisation of the Eurasians is risky when the unit qualities of the parental stocks are not blended and the individual of a blended stock is a mosaic of such unit character.

Semmer concludes that social or racial prejudice is based on recognition of differences, but prejudice simply because of differences does not exist. There is no feeling of hatred between the Spaniards and Indians in spite of differences in colour, speech, habits and dresses. The difference is only an element in the total situation, sometimes it may be the symptom and not the cause of the disease. The main determinant consists in the baulked impulses of the politically, economically and culturally dominated group. Differences are emphasised because they offer the readiest rationalisation for defence against real or fancied dangers. It is for the accentuation of the dynamic relation that the Hindu-Muslim tension exists. The policy to multiply such relations of a group with different groups is destructive of its vitality. When any tension occurs the reaction may aim at the immediate extermination of the threatening force for the restoration of the inter-group equilibrium, but history shows that men cannot be made to change their opinion by direct coercion. This is an instinctive mode of reaction in which the end is directly aimed at and is characteristic of the lower order of animal behaviour. Reason works through stratagem in a round-about way. The strategy that reason is to employ in liquidating the baulked impulse of social prejudice should be far remote from the end and will prove efficient in proportion as it operates unconsciously of the goal. This very remoteness of the measure of the social process is the cause of its great efficiency. This is somewhat of the nature of a weight the power of which, when thrown on the longer end of a lever, is multiplied in transmission. Gandhiji's Satyagraha movement to stop the drinking habit of the masses fails because of its very clear and direct attack upon the end. Improvement of conditions, introduction of good music, drama, education, etc., would, however slowly, have produced a more stable effect. So legislation often fails to effect social amelioration. In flattening a warped iron-plate strokes are to be judiciously administered first outside the warped part otherwise new defects would be produced. Should we think that humanity can be more readily straightened than even an iron-plate ?

LETTERS TO THE EDITOR.

CONTENTS.

On Bayes' Problem.

FOLLOWING Karl Pearson[1] we will consider the famous problem of Bayes in the form below.

An "event" has occurred a times out of $a + b = c$ trials, where we have no *a priori* knowledge of the frequency of the event in the total population of occurrences. What is the probability of its occurring d times in a further $d + e = f$ trials?

Various solutions of this problem, which are, however, not entirely satisfactory, have been given. The following solution appears to be the most satisfactory among those given so far.

We shall call the occurrence of the event a success. Let the probability of success of the event in the total population of trials be p. Then the chance that there will not be more than a successes in c trials is given by

$$P = q^c + {}_cC_1\, q^{c-1}\, p + \cdots + {}_cC_a\, q^b\, p^a \quad (1)$$

where $q = 1 - p$, and $c = a + b$.

Equation (1) is of the cth degree in p. Hence when solved for p we will get c roots. It can, however, be easily shown that *there is only one root which is between* 0 *and* 1. We shall consider here only this solution of equation (1).

Let us take some level of significance, say 0·05. Putting $P = 0\cdot05$ in (1) we solve for p.* Let p_1 be the solution. This means that if p has a value greater than p_1, the chance of obtaining not more than a successes in a random sample of c trials is less than 0·05. Hence on our level of significance our sample of c trials of which a are successes could not have been obtained from a population in which the probability of success is greater than p_1. Thus p_1 is the higher limit of p.

* The method of solution is given in the fuller paper to be published shortly.

Similarly the probability of getting not more than b failures in c trials is

$$P = p^c + {}_cC_1 p^{c-1}\, q + \cdots + {}_cC_b\, p^a\, q^b \quad (2)$$

Putting $P = 0\cdot05$, we solve (2) for p. Let p_2 be the solution. In a manner similar to the above we can see that p_2 is the lower limit of p.

Hence on our limit of significance

$$p_2 < p < p_1 \quad (3)$$

If p_1 be the probability of success in the population, then the chance of obtaining d successes in f trials is

$$P_1 = \frac{f!}{d!\ e!}\, p_1{}^d q_1{}^e, \text{ where } q_1 = 1 - p_1,$$

and $d + e = f$.

Similarly, if we assume p_2 as the probability of success in the population, the chance of getting d successes in f trials is

$$P_2 = \frac{f!}{d!\ e!}\, p_2{}^d q_2{}^e, \text{ where } q_2 = 1 - p_2.$$

Thus the chance, P, of obtaining d successes in f trials when it is known that in

previous c trials there have been a successes, is given by

P lies between P_1 and P_2 (limits included) .. .. (a)

or

P_1 or $P_2 < P < P_3$, retaining the smaller of the two P_1 or P_2, where

$$P_3 = \frac{f!}{d!\ e!} p_3{}^d (1 - p_3)^e, \text{ and } p_3 = \frac{d}{f} \qquad (b)$$

(a) is to be used when p_3 is outside the interval from p_1 to p_2, and (b) when p_3 is within the interval p_1 to p_2, including the limits.

More details will be found in a paper to be shortly published.

S. R. SAVUR.

Poona 5,
December 21, 1936.

[1] Karl Pearson, *Biom.*, 1920-21, **13**, 1-16.

Absorption Spectra and Photo-dissociation of Simple Organic Molecules.

RECENTLY it has been shown,[1] that the photo-dissociation of polyatomic molecules formed by atoms of groups V and VI of the periodic table follows different lines according to the state of valency of the central atom. In a lower state of valency, *i.e.*, as long as chemical combination is brought about by the p electrons of the central atom the bond energies are decisive for the photolytic process. In the state of maximal valency involving the activation of the two electrons of the s^2 group, the thermochemical difference between the atomic energy of formation of such a molecule and the corresponding one of lower valency determines the decomposition by light. Since according to the view of the pair bond theory of valency the unexcited carbon atom is divalent only and becomes tetravalent only by an excitation which involves the activation of the s^2 group, we have re-investigated the absorption spectra and photo-dissociation of a number of halides formed by atoms of group IV and find indeed, that the same view is confirmed there too.

The first photo-dissociation of, *e.g.*, methyl iodide is not represented by the process $CH_3I \rightarrow CH_3 + I$, but by $CH_3I \rightarrow CH_2 + H + I$. The dissociation products are an iodine and a hydrogen atom, and a CH_2 molecule, which is not a radical but a saturated molecule like $SnCl_2$ or $PbCl_2$. The absorpion spectrum corresponds to a transition from the ground state of CH_3I to that repulsive curve which is produced at decreasing internuclear distance by the system $CH_2 + H + I$ on account of the rigorous divalency of unexcited C (*i.e.*, the lack of free valencies in unexcited CH_2).

The simultaneous splitting off of two atoms of simple organic molecules receives confirmation by the following experimental results :—

(1) In the case of $SnCl_4$, the only one for which all thermochemical data are available, the long wave limit[2] corresponds to the energy difference $D(SnCl_4) - D(SnCl_2)$.

(2) We estimate the dissociation and bond energies of the molecules CH_2, CHX, CX_2 (X = Cl, Br, I) from the atomic energies of dissociation of CH_4 and CX_4 according to the known ratio $D(SnCl_4) : D(SnCl_2) = 5 : 3$. Using these values, we find that the beginnings of the first selective absorption of the twelve alkyl halides investigated are in agreement with the energy differences $D(CX_4) - D(CX_2)$, $D(CHX_3) - D(CHX)$, etc.

(3) Wherever the whole of the selective absorption falls into the quartz ultraviolet, we find three regions of selective absorption whose long wave limits and maxima are of the order of the energy difference $^2P_{3/2} - {}^2P_{1/2}$ of the halogen atom provided the molecule contains a sufficient number of Br or I atoms such as $SnBr_4$, CI_4, CHI_3, etc. They correspond obviously to the photolytic processes $CX_4 \rightarrow CX_2 + 2X\ (^2P_{3/2})$, $CX_4 \rightarrow CX_2 + X\ (^2P_{3/2}) + X^*\ (^2P_{1/2})$, and $CX_4 \rightarrow CX_2 + 2X^*\ (^2P_{1/2})$. The existence of the third maximum due to the simultaneous excitation of two halogen atoms appears to exclude any other explanation.

These results promise to lead to an experimental determination of the bond energies of organic molecules ; thus the C — H bond in the saturated molecule CH_2, formed by divalent carbon, has 114 K.cal/mol. They also show that a fundamental change in the interpretation of the photo-dissociation of many organic molecules is necessary. Incidentally they show directly that the unexcited carbon atom is divalent only, in accordance with the pair bond theory of valency. They fall into line with certain results and considerations of Mecke Norrish,

Terenin, a. o. A detailed report will be given elsewhere.

Y. P. Parti.
R. Samuel.

Department of Physics,
Muslim University, Aligarh,
December 15, 1936.

[1] R. K. Asundi and R. Samuel, *Proc. Phys. Soc.*, 1936, **48**, 28; Mohd. John Khan and R. Sammuel, *Ibid.*, 1936, **48**, 626; S. L. Hussain and R. Samuel, *Curr. Sci.*, 1936, **4**, 734.

[2] The first absorption region, recorded by R. S. Sharma (*Bull. Ac. Sci. Allahabad*, 1933, **3**, 87) is due to Cl_2.

The Spectrum of Argon IV.

The spectrum of a condensed discharge through argon gas was photographed in the visible and the quartz regions at various stages of excitation and the lines due to A IV isolated. The data thus obtained led to the discovery of several regularities in the lines. The following table gives some of the 4p terms and in the second column their probable identification is indicated.

Term	Identification
289244	4p $^4D_{1\frac{1}{2}}$
289765	$^4D_{2\frac{1}{2}}$
291430	$^4P_{\frac{1}{2}}$
291750	$^4P_{1\frac{1}{2}}$

It may be remarked that there is entire agreement between the present identification and some of the terms previously reported by Boyce,[1] who worked in the Schumann region. The complete scheme will be published shortly.

S. G. Krishnamurty.

Science College,
Waltair,
November 17, 1936.

[1] J. C. Boyce, *Phys. Rev.*, 1935, **48**, 396.

Crystal Structure of Hydrazobenzene—The Space Group.

From the crystallographic measurements, the crystals of hydrazobenzene are known to belong to the orthorhombic bipyramidal class. The axial ratio is

$a : b : c :: 0{\cdot}9787 : 1 : 1{\cdot}2497.$[1]

Rotation photographs taken about the three crystallographic axes give the following values for the dimensions of the unit cell

$a = 7{\cdot}35$ Å, $b = 7{\cdot}50$ Å, $c = 18{\cdot}75$ Å.

The axial ratio obtained from these agrees very well with that given in Groth except that $(c : b)$ is doubled.

A number of oscillation photographs were taken about the b and the c axes at suitable intervals. From the reflecting planes identified it is found that (hol) planes are halved when (h+l) is odd, (okl) planes are halved when (k+l) is odd, and (hko) planes are halved when (h+k) is odd. These halvings correspond to the space group Q_h^2. Also all (hkl) planes are halved when (h+k+l) is odd. This shows that the lattice is a body-centred lattice. Banerji and N. M. Saha[2] have recently published some results on the arrangement of benzene rings in crystals of hydrazobenzene and they have assigned, contrary to our results, the space group D_{2h}^5 (Q_h^5 in our notations).[3]

The space group Q_h^2 requires eight asymmetric molecules to complete the symmetry of the cell. The number of molecules (mol. wt.—184) calculated from the above dimensions and the specific gravity of the crystals (found to be 1·18) is only four (accurately 3·99). This indicates the presence of some symmetry in the molecules of hydrazobenzene and these may be (i) axis of symmetry parallel to the a, b, or c axis, or (ii) a centre of symmetry. Crystals of hydrazotoluene are also being studied and the details of the structure of both crystals will be published elsewhere.

Jagdish Shanker.
Mata Prasad.

Chemical Laboratory,
Royal Institute of Science,
Bombay,
January 12, 1937.

[1] *Cf.* Groth, *Chem. Krystallg.*, 5, p. 59.

[2] *Abstracts of Papers*, Mathematics and Physics Section, Indian Science Congress, Hyderabad Session, 1937.

[3] Astbury and Yardley, *Phil. Trans.*, A, **224**, 221.

Resolution of Bicyclo-(2 : 2 : 2)-octane-2 : 5-dione-1 : 4-dicarboxylic Acid.

The synthesis of bi*cyclo*-(2 : 2 : 2)-octane-2 : 5-dione-1 : 4-dicarboxylic acid, starting from succinosuccinic ester has been reported by one of us,[1] and it was thought that a resolution of the acid would, in addition to its intrinsic interest, offer an additional proof as to the correctness of its constitution. For this purpose the acid was combined with

brucine (2 molecules) when a salt separated. Specific rotation of the brucine salt after five recrystallisations $[\alpha]_D^{26°\cdot5} - 70\cdot87$ (C = 2·25 in pyridine). The acid liberated from the salt had $[\alpha]_D^{25°} = +23°\cdot85$ ($l = 1$; C = 2·13 in water). The mother liquor (of the brucine salt) yielded on three successive evaporations and filtrations the pure salt of the *l*-acid which when liberated free had $[\alpha]_D^{28°\cdot5} = -23\cdot24$ ($l = 1$; C = 0·90 in water). In the same thermometer the inactive, *d* and *l* forms melted at 268°, 271° and 271°, respectively.

P. C. GUHA.
S. K. RANGANATHAN.

Department of Organic Chemistry,
Indian Institute of Science,
Bangalore,
December 17, 1936.

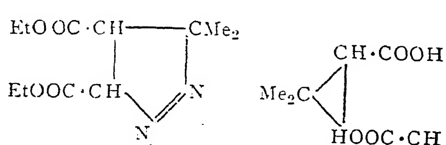
[1] *Curr. Sci.*, 1936, **5**, 9.

A New Method of Synthesis of Caronic Acid and Homocaronic Acids.

CARONIC ACID (1 : 1-dimethyl*cyclo*propane-dicarboxylic acid), the ultimate degradation product of a number of naturally occurring bicyclic compounds, *e.g.*, carone, Δ^3- and Δ^4-carene has been synthesised by Perkin and Thorpe[1] from ethyl α-bromo-ββ-dimethyl-glutarate, by Kotz[2] from ethyl *iso*propylidene dimalonate and by Kon and others[3] from Guareschi-imide.

Although diazomethane and diazoacetic ester have found application in the synthesis of some monocyclic and bicyclic derivatives of compounds of the thujane group,[4] no synthetic investigation seems to be on record in which dimethyl-diazomethane has been used for such synthesis.

Dimethyldiazomethane has now been found to react with ethyl fumarate and maleate at a temperature of about − 18° C. to give the pyrazolone derivative (I) which when heated to about 240–50° loses nitrogen yielding ethyl *trans*-caronate (b.p. 240°) as the primary product. This ester yields *trans*-caronic acid (II) on hydrolysis with 5% KOH on water-bath.



(I) (II)

The product obtained after crystallising twice from water melted at 213° ; mixed melting point with a genuine sample of *trans*-caronic acid remained undepressed. The acid obtained from the mother liquor on treatment with acetic anhydride at 220° in the usual manner gave *cis*-caronic acid m.p. 175°. It is interesting to note that ethyl maleate also gives *trans*-caronic acid under identical conditions; evidently the *cis*-variety is unstable under the conditions of the experiment (*cf.* Formation of *trans*-caronic acid from Δ^3-carene by oxidation).[5]

Dimethyldiazomethane reacts similarly with diethyl glutaconate to yield finally homocaronic acid which has been recently synthesised by Owen and Simonsen[6] from ethyl Δβ-*iso*hexenoate.

The action of dimethyldiazomethane is being tried with a number of other suitable unsaturated compounds with a view to synthesising carane and other compounds of the carane group.

P. C. GUHA.
D. K. SANKARAN.

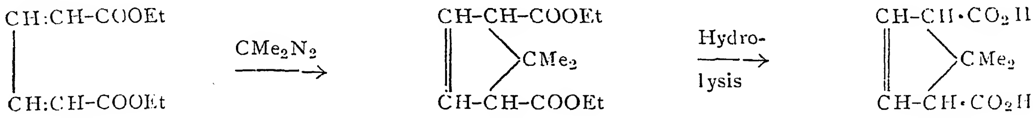
Department of Organic Chemistry,
Indian Institute of Science,
Bangalore,
December 9, 1936.

[1] *Soc.*, 1899, **75**, 56-57.
[2] *J. pr. Chem.*, 1907, (2), **75**, 501.
[3] *J. C. S.*, 1921, **119**, 1322.
[4] *Proc. Ind. Sci. Cong.*, Presidential Address (Chemistry Section), 1936, p. 146; Philips, Ramage and Simonsen, *J. C. S.*, 1936, 828; Rydon, *J. C. S.*, 1936, 829; Ranganathan, *J. Ind. Chem. Soc.*, 1936, **13**, 419.
[5] Gibson and Simonsen, *J. C. S.*, 1929, 305.
[6] *J. C. S.*, 1933, 1225.

A New Method of Synthesis of *Iso*-dehydroapocamphoric Acid.

*ISO*DEHYDROAPOCAMPHORIC acid (III) was synthesised by Komppa[1] starting from dimethyl glutaric ester *via* ethyl oxalodimethylglutarate (diketoapocamphoric ester) and dihydroxyapocamphoric acid.

As the first experiment tried on the possibility of formation of *cyclo*pentane compounds by the action of dimethyldiazomethane upon butadienes containing a system of conjugated double bond, the diazo compound has been found to add up to diethyl muconate (I) to yield diethyl *iso*dehydroapocamphorate (II). The ester (II), b.p. 200°/100 mm., gives on hydrolysis the corresponding acid, m.p. 208–209° (Komppa, m.p. same), and the



(I) (II) (III)

anhydride prepared on treatment with acetyl chloride, m.p. 195° (Komppa, m.p. same).

Further work is in progress by way of extending this reaction with other conjugated double bonded systems.

P. C. Guha.
D. K. Sankaran.

Department of Organic Chemistry,
Indian Institute of Science,
Bangalore,
January 9, 1937.

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[1] *Annalen*, 1909, **368**, 146.

A New Strain of Mid-Late Kolamba Rice.

In the Bombay Presidency the coastal districts of Thana and Kolaba grow nearly 600,000 of acres annually, representing roughly 30 per cent. of the total acreage under rice in the Presidency. The most widely grown variety of rice is Kolamba. It is a late variety, fine grained, and produces a good table rice. Compared to other varieties it fetches better prices and is usually grown by cultivators as a money crop.

One of the major aims of the Agricultural Department has been to spread the Kolamba type of rice as wide as possible. This has been achieved by releasing improved early and late strains of Kolamba. The Department had still on hand the problem to evolve a type possessing fine grains combined with high yield and early maturity which would replace mid-late coarse grained varieties extensively grown in the two districts. Exploitation of the local Kolamba material was of no avail in this direction. Hybridization was the only alternative.

Although many crosses were made, only one of these, involving a late, fine grained and high yielding Kolamba strain, K 226, and a mid-late, coarse but long grained Kolamba, K 164, yielded desirable combinations. From this cross two promising fine grained cultures were obtained. Of these, one proved consistently high yielding and competed successfully with the bold-grained rices. The strain is designated K 540.

The field trials of K 540 in the Thana district proved a great success from the very beginning and the cultivators took up the strain without hesitation. During the last three seasons (1933–34–35) it has been compared at various places with mid-late large grained varieties such as Dodki, Dangar-wel and Patni and has given an average of 2385 lb. per acre, as against 2262 lb. of the local varieties. Its highest yield was 2688 lb. and lowest 1990 lb. per acre.

Kolamba 540.

K 540 is of medium height (140 cm.) with an average of little over 6 tillers per plant. The earheads are very compact (see photograph). The strain ripens in 130 to 135 days. The average length of the grain is 7·59 mm. and breadth 2·17 mm. Seventy-five to seventy-seven grains are required to weigh a gramme, as against thirty-five to fifty grains of the coarse varieties. The natural test weight of paddy of the new strain is 45 lb. per Imperial bushel. The fine quality of K 540 fetches a premium of Rs. 10 to 15 per candy of 1400 lb.

The strain is now spreading rapidly in the two districts of Thana and Kolaba. The

preliminary field trials in Gujrat, Ahmednagar and Ratnagiri districts indicate that K 540 may prove a valuable variety in those regions also.

B. S. KADAM.

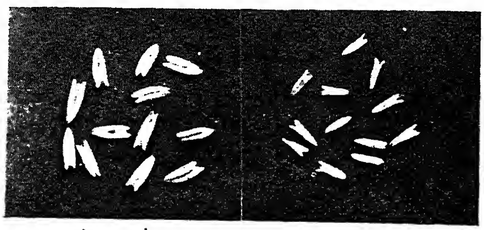
Rice Breeding Station,
Karjat (Kolaba),
October 19, 1936.

The Occurrence and Inheritance of Earheads with Empty Anther Sacs in Sorghum.

THE details of the anthesis and pollination in sorghum have been published.[1] The numerous anthers with abundant pollen grains, night flowering, antheriferous pedicelled spikelets and the general arrangement and sequence of flowering, all point to a perfection in the pollination arrangement in sorghum, the premier cereal of dry tracts. It is therefore interesting to record an instance in this millet in which the anther sacs are empty with the resultant sterility of the earheads.

M.S. 1761 is a variety of yellow sorghum from Tiruttani in the Chittoor district of the Madras Presidency. It belongs to the group *S. durra* Stapf. Seeds of this variety were sown in 1934 and a crop raised. In 1935, one of the earheads from this crop (A.S. 4282) was sown and multiplied and its progeny was found to contain 50 well set earheads and 14 earheads with chronic male sterility and a chaffy look. Seeds from 6 out of the 50 normal earheads were sown and a third generation raised. Two of these segregated again and gave 47 normal heads and 18 sterile heads.

The sterile heads were examined and it was noted that the sterility was due to empty anther sacs. The normal anthers are deep yellow when fresh and dehisce well. The empty anther sacs are very light yellow in colour and do not dehisce. Normal anthers are about 3·3 mm. long and 1·0 mm. broad. Empty anthers are small and about 2·0 mm. long and 0·5 mm. broad. (See illustration.)



Normal Empty

Sorghum anther sacs.

A number of anther sacs from sterile earheads were examined and found to be devoid of contents. The stigmas were however normal and quite receptive to foreign pollen, so much so that by contact with neighbours odd grains could be found set on them, the percentage of such crossing varying according to proximity to available foreign pollen. Three earheads with empty anther sacs were selfed and no grains set on them.

It is remarkable that a single gene could play such havoc on so well organised an earhead as that of sorghum. Empty anther sacs that have proved a simple recessive character, have been recorded in maize.[2] As far as the authors are aware, this is the first record of the occurrence and inheritance of empty anther sacs as a simple recessive mendelian character in sorghum. This male sterility gene has, as in maize, been designated *ms*. *Ms* is a simple dominant to *ms*.

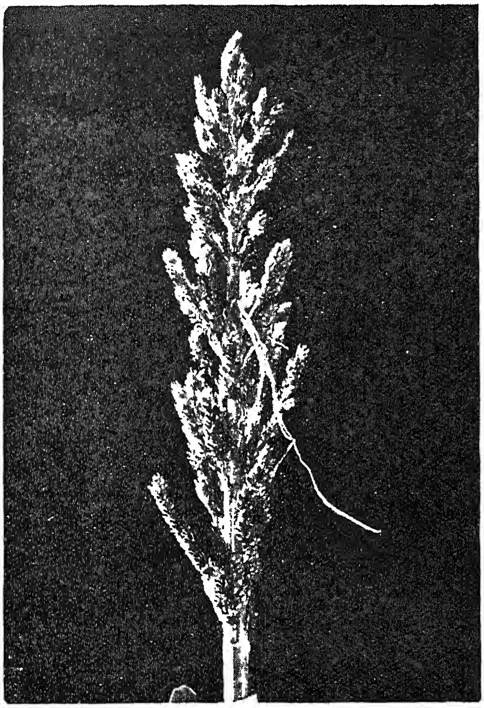
G. N. RANGASWAMI AYYANGAR.
B. W. X. PONNAIYA.

Millets Breeding Station,
Coimbatore,
December 9, 1936.

[1] *Ind. Jour. Agric. Sci.*, 1931, **1**, 445-454.
[2] J. Herd, 1921, **12**, 138-141.

Roots from the Stalks of Sorghum Earheads.

IN the hot weather crop of 1936 in the third generation progenies of a cross between the sorghum varieties Kafir (*Sorghum caffrorum*, Beauv.) and Milo (*Sorghum caudatum*, Stapf var. *milo*) three plants were noticed with root-like protrusions on the freshly emerged earhead. These outgrowths grew perpendicular to the stem inside the head mass and then turned down. As the earheads grew, these projections (which proved to be roots from the stalk) also elongated. In one of the earheads the growing roots clasped the panicle branches below and impeded their free expansion. The growing roots were fresh in the period of rapid growth and in a fortnight wilted and dried up. In one of the three heads a single root arose from a joint on a panicle branch in the place of a branchlet. In the two other cases the root cluster started from a node in the central stalk. It originated in a bunch from one side of the stalk. At the rooting node there was a total suppression of the panicle whorl. In one case, there were five roots (Fig.) and in the other six roots



HP. 421.
Closer View of 420.

springing up. They varied in length from 2 to 13 cm. and in diameter from 2 to 3·5 mm. Two out of the five roots in one head and three out of the six roots in the other were branched. All the roots had root hairs when fresh. A section of the root showed that in structure it was like that of a normal root.

The lower nodes of the stalks of the sorghum plant are capable of producing stilt roots.[1] Given sufficient facilities the nodes higher up can also root. Axillary buds are potential shoots that develop when stimulated; so also are the roots potentially present in the root band at the node. One instance is on record in which roots arose from a wound in the leaf-sheath of sugarcane.[2] That profuse root formation both on the stem and the leaves of many species of plants can be produced under the stimulus of certain chemicals such as carbon monoxide gas and certain unsaturated hydrocarbon gases as ethylene, acetylene and propylene has been experimentally shown.[3,4] Mutilation and natural injuries have also been known to induce root development in certain plants.

To our knowledge there has been no record of an instance in Gramineæ of roots developing from the stalks of the earheads. This rare phenomenon seems therefore to be a faint echo of that ancient history of the plant which in ages past initiated the differentiation of structures into shoot and root. This somatic reversal might have been induced through the wide mating under radically different environmental conditions. The formation of bulbils,[5] the forking of leaves and awns,[6] the forking of midrib,[7] and now the production of root from the central stalk of the earhead seem as it were to be episodes in this ancient evolutionary history.

G. N. Rangaswami Ayyangar.
A. Kunhikoran Nambiar.
Millets Breeding Station,
Coimbatore,
November 19, 1936.

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[1] *Curr. Sci.*, 1935, **3**, 485-86.
[2] *Proc. 4th Cong. Int. Soc. Sugarcane Technology*, 1932, *Bull.* No. 73, 19.
[3] Contributions from Boyce Thompson Institute, 1933, **5**, 1-17.
[4] Contributions from Boyce Thompson Institute, 1933, **5**, 351-69.
[5] *Curr. Sci.*, 1935, **3**, 362-63.
[6] *Curr. Sci.*, 1935, **4**, 316-17.
[7] *Madras Agric. Jour.*, 1930, **18**, (10), 526-30.

Internal Proliferation in *Carica papaya* Linn.

In a recent issue of the *Current Science*[1] Sayeeduddin and Bari have published an interesting article under the above caption. Without offering any comment whatsoever, I may point out that a perusal through the literature on the subject shows that similar abnormalities in the fruits of *Carica papaya* were already recorded and described from Honolulu by Bergman in 1921 and later in 1925 also.[2] The authors are, therefore, referred to the above two important papers before actually taking up any detailed investigation in connection with the internal proliferation in the fruits of *Carica papaya*.

R. Shah.

Agricultural Research Institute,
Sabour, Dist. Bhagalpur (Bihar),
January 10, 1937.

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[1] *Curr. Sci.*, 1936, **4**, No. 10, 740-41.
[2] Bergman, H. F., *Bot. Gaz.*, 1921, **72**, No. 2, 97-101; *Bot. Gaz.*, 1925, **79**, No. 2, 222-23.

REVIEWS.

Cathode-Ray Oscillography. By J. T. MacGregor-Morris, M.I.E.E., and J. A. Henley, M.Sc. (Eng). (Chapman and Hall, Ltd., London), 1936. Pp. xiii + 249 with 151 illustrations. Price 17*sh.* 6*d.*

Prof. MacGregor-Morris and his associates are known for their interest and work in cathode-ray oscillography: it is appropriate that this book has been written by them. They give a brief history of the development of the cathode-ray oscillograph from the time of Thomson and Braun up to date and describe the physical principles underlying its theory and performance. In Chapters 4 and 5, they examine in some detail the constructional features and performance-characteristics of a number of makes of (*a*) the cold cathode type (Rogowski, Finch, General Electric, Knoll, etc.), (*b*) the hot cathode gas-filled type (von Ardenne, Cossor, Ediswan, Standard Telephones and Cables, etc.), and (*c*) the hot cathode high vacuum type (von Ardenne, Ediswan, General Electric, RCA, etc.). On page 94 is mentioned the ingenious Messner 200 kv. deflection chamber which does away with the potential divider. The multi-element Knoll oscillograph is very interesting. It is surprising to read about a 1000 volt cold cathode instrument (page 78).

Chapter 6 contains an inadequate and almost superficial discussion on the auxiliary apparatus such as power supply, pumps, etc. In another edition this can either be omitted or rewritten adequately. The authors refer to the suggestion of Finch to measure accelerating voltages by electron diffraction patterns. The discussion on time bases is useful and covers the ground fairly well. The beginner would have been helped by fuller data regarding complete circuits and their frequency ranges.

The cold cathode oscillograph finds its chief uses in investigations on lightning discharges and travelling waves, on power transmission lines and properties of insulating materials under impulsive voltages. The principal circuit arrangements for time sweeping, beam trapping and releasing, etc., are discussed in Chapter 9. The next one deals with a few important applications of the hot cathode instrument in different lines of work. The book closes with a brief outline of television transmission and reception.

Containing much useful information gathered together from many scattered sources, the book will gain greatly if the next edition is revised thoroughly to be free from the considerable number of easily avoidable errors particularly in the important Chapters 2 and 3 dealing with the dynamics and the optics of the electron. Here are some that were noticed in going through the book.

It is more appropriate to write "ionisation" for "excitation" (page 12, line 5). The velocity of the electron is not given by $\sqrt{\frac{2\,e\,V}{m_v\,300}}$ but by the formula that follows it (page 17). On pages 20, 21, 27, etc., the symbols V, ϕ, E and ϵ are used to denote electric potential sometimes in volts and sometimes in electrostatic units. There is a similar confusion in regard to e, the charge on the electron. The radius of curvature of the path of an electron is ρ on page 22 and r on page 27. On page 27, $v \cos at$ should be $(v \cos \alpha)t$. There appears to be no need for the word "infinite" on page 19, line 5. The reference to fig. 6(*c*) (page 32, line 6) should clearly be to 11(*c*) on page 29. The symbols in the first line on page 45 need correction. Considering the importance of Chapters 2 and 3, it will be useful to derive equations (11) and work out in more detail the lens equations, both magnetic and electrostatic.

Fig. 20 referred to on page 91 should surely be fig. 48. Again three-quarters down page 170, fig. 1 should be fig. 99.

The printing is good and the illustrations excellent.

R. E.

Television Reception, Construction and Operation of a cathode-ray tube receiver for the reception of ultra short wave television broadcasting. By Manfred von Ardenne. Translated by O. S. Puckle, A.M.I.E.E. (Chapman and Hall, Ltd., London), 1936. Pp. xv + 121 with 96 illustrations. Price 10*sh.* 6*d.* net.

The author is well known in Germany and outside for his valuable contributions to radio

technique, particularly in developing the cathode-ray oscillogrph tube and television reception. The translation from German into English has been ably carried out by Mr. O. S. Puckle, himself a recognised British investigator in the field. A very useful feature to the television enthusiast in Great Britain is the inclusion of details of British television transmissions and of television apparatus of British make. Discussion is confined to technique and apparatus developed by the author and by the translator.

The book begins with a succinct statement of the essential technical aspects of television transmission such as wave-length, field-strength, wave-form, etc., and of reception requirements involving inevitably the use of the high vacuum cathode-ray tube with its associated circuits for time bases and synchronisation. The second chapter contains much interesting and useful information on the theory, details of construction and performance of the high vacuum cathode-ray tube. This is followed by a discussion of the power supply to the oscillograph tube, time bases and their synchronisation with the transmission. The all vacuum tube time base circuit originated by Mr. Puckle and his co-workers is also described. The circuit diagrams and data regarding components give all the necessary details to enable the constructor to build up his own apparatus. The effects of different line and picture frequencies are intriguing (pages 75–78).

The chapter on amplitude filter to separate the synchronisation pulses emphasises the need for further experimental work.

While the difficulties of the very low wave-lengths are common both to sound and picture receiving equipment, the design and operation of the latter is governed by the need for uniform amplification over a frequency band width, not of 10 to 15 kilohertz, but of at least 1 megahertz. And the stage gain has to be of the order of 10 to 15 times to prevent self-oscillation and to keep down the cost. These considerations are dealt with in Chapters VII and VIII.

The results of television reception with the equipment described in the book are summarised in the last chapter.

This modest volume is packed with very useful and worthwhile information presented with admirable clarity and economy of words. There is much that is new, and the detailed requirements of the technically minded amateur constructor are anticipated at every turn. The descriptions of intricate apparatus and of physical principles are always lucid and accurate though without the aid of mathematical treatment. The illustrations are excellent and very well chosen.

When a revised edition incorporating progress subsequent to 1935 will be brought out, the following will perhaps receive attention. In Fig. 39A, the resistances are better shown differently from the transformer windings, say as in Fig. 39B. In Fig. 48, page 60, R_1 is not marked. On page 64, the term *vigorously pointed out* can be replaced by *emphasised*. On page 93, line 18, *transmission* would perhaps be more suitable than *transmitter*.

R. E.

Electronics and Electron Tubes. By E. D. McArthur. (John Wiley and Sons, New York; Chapman and Hall, London), 1936. Pp. viii + 173 with 89 figures. Price 12*sh.* 6*d.* net.

The study of electronics and of the applications of electronic devices in daily life continue to fascinate a growing number of people. The present work is by an active worker in the field in one of the national homes of electronics, the research laboratories of the General Electric Company of the U.S.A.

The book begins naturally with a brief mention of the nature and properties of electrons, atoms and molecules and radiant energy; the elements of the kinetic theory of gases and the phenomena of excitation and ionisation occupy the next chapter. The third is mainly concerned with thermionic emitters and emission and the associated phenomena; photo-emission is touched upon. Space current characteristics of single and multi-grid vacuum tubes for continuous and varying voltages are taken up next. The latter topic is inadequately treated, considering its importance. There are a few pages on A, B and C class amplifiers. Amongst the uses of vacuum tubes mentioned by the author, that for producing artificial fever for the treatment of certain diseases is of interest.

Cathode-ray tubes, tubes for generating micro waves and high voltage high vacuum rectifier tubes are briefly discussed. The last chapter on the construction of electron tubes could well have been much more comprehensive, in view of lack of any literature on the subject.

The feature of the book is the survey of the physical action inside gas or vapour filled electronic tubes and their practical

applications for control and conversion of power.

The simple and direct language and the absence of any mathematics (except for a few formulæ) should enable even a comparatively non-technical reader to follow the clear, and authoritative discussion of the basic ideas and principles underlying the main electronic phenomena and devices.

The printing and get-up of the book are excellent. R. E.

The Thermochemistry of Chemical Substances. By F. Russell Bichowsky and Frederick D. Rossini. (New York: Reinhold Publishing Corporation; London: Chapman and Hall), 1936. Pp. 460. Price 35*sh*.

The present book supplies an assembly of the tables of values for the heats of formation of chemical substances. It is well known that Dr. Bichowsky collated all published data for the International Critical Tables. The present book is a complete revision and extension of that work. The table of data covering 150 pages deals with different elements in their atomic states as well as molecular formation. In the case of diatomic molecules the band spectra data for the lowest level as well as for other energy states have been supplied. For the majority of the polyatomic molecules forming different compounds the data being those derived from thermochemical investigations. In the case of the atoms the energy-states are derived from the tables of Bacher and Goodsmith and Russel Saunder's notation has been uniformly followed. Besides the tables there are 200 pages of texts furnishing explanations in support of the different values collected in the tables, giving full references for each of the investigations from which the data have been derived. There is further an alphabetical index of references of the different authors. This book thus is a great interest for workers in atomic and molecular physics. It had been difficult to secure the necessary data required in the investigations as the materials had been growing at such a rapid rate within recent times.

Recent Advances in General Chemistry. By Dr. Samuel Glasstone. (J. and A. Churchill Ltd., London), 1936. Pp. vii +430. Price 15*s*.

This book is a companion to the writer's *Recent Advances in Physical Chemistry* and is intended to bring before chemists the important developments in the "borderland between physical chemistry, on the one hand, and inorganic or organic chemistry on the other".

The book is divided into nine chapters which present, respectively, developments in the following topics: atomic disintegration, statistical methods, ortho- and para-hydrogen, deuterium and its compounds, electron diffraction by gases and vapours, solubility, the mechanism of reactions in solution, acid-base and salt catalysis, and simple organic free radicals.

The mode of treatment employed is particularly helpful to the graduate or post-graduate student. For instance, the chapter on Atomic Disintegration commences with an account of Rutherford's work relating to emission of protons as a result of disintegration by α-particles. The mechanism of disintegration, applicability of the laws of conservation of mass and energy, and the principle of energy levels are then presented in outline. This is followed by an account of the discovery of the neutron, its production, important properties and its employment in disintegration experiments. Then follows a similar account with regard to the positron. The neutrino and the negative proton are very briefly touched upon. An account is then given of the work relating to disintegration by protons and deuterons and the results obtained are briefly discussed. This is followed by a comprehensive account regarding work on artificial radioactivity and the methods employed in chemical identification of unstable isotopes. The use of neutrons as projectiles and the types of disintegration produced by them are next mentioned in outline. Short discussions on nuclear stability, the trans-uranium elements and the applications of artificial radioactivity form the concluding topics of this chapter.

Every chapter is written with due regard to the relative importance of the topics discussed and includes a fairly comprehensive list of references to original work. The book is written in language which is at once clear and concise. The printing and get-up is excellent. It can be heartily recommended for careful study by graduate and post-graduate students of chemistry and by professional chemists as well.

K. R. K.

Recent Advances in Physical Chemistry. By Samuel Glasstone, D.Sc. (J. and A. Churchill Ltd., London), 1936. Third Edition. Pp. 477. Price 15s.

The book includes the following chapters :—the Electronic Theory of Valency, the Parachor, Dipole Moments, Molecular Spectra, Homogeneous Gas Reactions, Photochemical Reactions, the Properties of Surfaces, Heterogeneous Catalysis, and Strong Electrolytes. The subjects have been treated in an essentially non-mathematical form, so that students with ordinary mathematical equipment may grasp the significance of the advance in our knowledge of these subjects made in recent years. The references at the end of each chapter have been carefully selected, and will be helpful to those who intend to study the problems at first hand. A bold attempt has been made to give an elementary exposition of the principles of quantum mechanics in their application to problems of valency and molecular structure, but the reviewer has misgivings if such attempts can ever be made really successful.

The book on the whole has however been very well written and deserves the popularity which it has already won among senior students of Chemistry in Universities.

J. C. G.

Tungsten; a Treatise on its Metallurgy, Properties and Applications. By C. J. Smithells, D.Sc. (Chapman and Hall, London), 1936. Pp. 272. Price 25s. net.

The first edition of this book was published in 1926, some twenty years after the granting of the first patent for the manufacture of tungsten filaments. An enormous amount of work was carried out on tungsten during these twenty years ; in spite of that the last ten years has brought a great increase in our knowledge of the properties of the metal and of its industrial applications ; the second edition of this book is nearly twice the length of the first.

The development of wireless transmission has stimulated work on thermionic emission, much of which has been done with tungsten filaments, though they have now been replaced to some extent by more efficient sources. The most important of the new industrial applications of the metal lies probably in the development of the hard tungsten carbide cutting tools. In milling operations with these tools, the cutter speeds are three to four times higher and the table speeds two to three times faster than those used with high-speed steel cutters. The carbide has also been applied with outstanding success in the field of dies ; for example in the drawing of steel wire 264 chilled iron dies were employed in a 12-day period ; during the same period a tungsten carbide die drew 20 per cent. more wire and suffered no die enlargement. Sand blast nozzles fitted with carbide inserts have a life six hundred that of nozzles made from manganese steel. Important developments have also taken place in the production of non-ferrous tungsten alloys in which tungsten is a major constituent, and improvements have been effected in both the mechanical and magnetic properties of tungsten steels.

The field of application has become so large that the author has obtained the co-operation of experts in the preparation of certain chapters of the book. The information given covers a wide field and the book can be regarded as a real contribution to metallurgical literature.

T. S. W.

Annual Review of Biochemistry. Vol. V, 1936. Edited by James Murray Luck. (Stanford University P.O., California, U.S.A.). Pp. ix + 640, Price $ 5·00.

The colossal task of bringing together in one volume the reviews of the progress of Biochemistry in the year 1935, has been accomplished in this annual publication, to whose periodic appearance research workers, the world over, eagerly look forward. This ably edited review comprises 26 sections each of which has been reviewed by authorities on a truly international basis, thus ensuring a publication not limited by regional considerations. This circumstance alone is compelling enough to bestow on this publication a place of respect and authority.

An idea of the comprehensiveness of this publication can be obtained, when it is mentioned that citations to about 3,800 papers from about 3,500 different workers are comprehended in it. It comprises 26 sections, and reviews on soil microbiology, application of X-ray methods to the elucidation of the structure of compounds of biochemical interest and clinical application of biochemistry, subjects not treated in the earlier volume, have been included in it. The phenomenal output of research on vitamins has made it necessary to

review the work under the heads, the fat-soluble and water-soluble vitamins. Among other departures, mention may be made of the addition of a separate section on the chemistry and metabolism of the compounds of phosphorus. The section on animal pigments will serve as a complement to the section on plant pigments which appeared in the previous volume. There are also other additions which will be welcomed. The section on permeability, alkaloids, chemical embryology and immunochemistry which found a place in the earlier review, do not find a place in the present volume.

The review will undoubtedly stimulate and inspire further enquiry into the various problems dealt with. The contributors and the Editors have placed the readers under a deep debt of gratitude for placing in their hands a volume which they will find not merely valuable but indispensable.

Experimental Enzyme Chemistry. By Henry Tauber. (Burgess Publishing Company, Minneapolis, Minn., U.S.A.), 1936. Pp. v + 118.

This recent mimeographed publication by an active worker in the field of Enzyme Chemistry, will be warmly welcomed by biochemists, as it provides in a handy volume, useful notes on the more common enzymes. No attempt at completeness is made and the book is not intended to provide a comprehensive review of all the recent researches on enzymes or to duplicate material already provided in the books readily available. The author has set himself the task of merely presenting in a classified form, an account of the more recent advances and he has in a large measure succeeded in doing this.

The book contains 11 chapters. The first furnishes some useful notes on the general aspects of enzyme actions. Subsequent chapters deal with the preparation and reactions of individual enzymes. Considerable space is devoted to the discussion on the chemical nature of enzymes and it is pointed out that many enzymes are proteins. This should be expected from a worker belonging to the American School of Enzyme Chemists, who have succeeded in crystallising a number of enzymes, all of which happen to be proteins. It should, however, be recognised that this circumstance does not nullify the *carrier* theory, promulgated by Willstatter. Valid arguments have been provided to show that enzymes are not mere proteins. The value of a theory has to be judged by the extent to which it can provide convincing explanation for experimental observations, and judged from their standard the *carrier* theory has been extremely successful. It is surprising that while discussing the *carrier* theory which postulates that proteins are only exchangeable carriers of the active groups, replaceable by other colloids of high molecular weight, the author should have said "the active principle has never been isolated, and *there is little hope that it ever will be*" (page 13, *italics, ours*). It is not less surprising to find that the author considers that the attempts to separate proteins from the active portions of the enzymes, "retarded the advancement of our knowledge of the chemical nature of enzymes". Few will agree with this view of the author.

Any discussion on the merits of the rival theories should be considered out of place in a review. The reviewer is, however, tempted to point out that such arguments as those advanced by the author on page 13 "glutathione acts in every respect like an enzyme. ....Then according to the carrier theory, the tripeptide would be only the carrier of the active principle", do not carry conviction.

The bibliography is the most valuable feature of the book. It is comprehensive and most of the references are to recent literature. Several citations are also given for reviews of recent researches on different enzymes. The book will be particularly valued for this feature. There are a few obvious errors, such for instance as that on page 112, where it is said that carboxylase acts on methyl glyoxal and acetaldehyde; no mention has been made of glyoxalase. These and others will, we are confident, be eliminated in the next edition. We should also like to see more experimental details in a book entitled *Experimental Enzyme Chemistry*, so that the book may be useful in the laboratory. The present mimeographed edition should be viewed as a definite stage in its evolution into a more thorough and comprehensive laboratory manual.

CENTENARIES

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University Librarian, Madras.

Guyton, De Morneau (1737-1816)

DE MORNEAU GUYTON, a distinguished French chemist, famous as the father of the modern chemical nomenclature, was born on January 4, 1737, at Dijon. His father was a professor of law and in spite of his early manifestation of a remarkable aptitude for practical mechanics, he was admitted in the Law School of the University of Dijon in his sixteenth year. He practised law at Paris from 1757 till 1761, when he was appointed Advocate-General in the Parliament of Dijon, although he was only 24. He held this post till 1782. He took part in politics and in military life till 1797, when he became the Director of the Polytechnic School, of which he was one of the founders. During the period 1800 to 1814, he held the appointment of the Master of Mint.

A Good in Disguise

The story of Guyton turning to chemistry savours of the Viswamitra-Vasishta episode. What turned his attention to the study of chemistry was a slighting remark which Prof. Chardenon of Dijon made in reply to an observation of Guyton at the close of a lecture on chemistry. Smarting under this insult, with "practice for his master and melted crucibles and retorts for tutors", Guyton set himself for a thorough, though private, study of chemistry until he obtained such a mastery over his subject as to draw from Prof. Chardenon himself the public acknowledgment that he was "born to be an honour to chemistry".

His Contributions to Chemistry

In his *Digressions academiques*, published in 1772, he set forth his views regarding phlogistan and crystallisation. One of his first successes was his process of disinfecting vitiated air by fuming with hydrochloric acid gas. This, he discovered in 1773. In 1774, he succeeded in establishing a course of extension lectures at Dijon for the dissemination of scientific knowledge and he himself conducted the lectures in chemistry continuously for thirteen years. He next turned his attention to industrial chemistry. In 1778, he founded a saltpetre manufacture on scientific principles and in 1783 he established the first soda-works of France. In 1794 he accompanied the French army into Belgium where he constructed a balloon and made a balloon ascent for military purposes.

Chemical Nomenclature

His chief fame justly rests on the pioneering work he did in establishing a scientific nomenclature in chemistry, which has stood the test of time till to-day. The chemical nomenclature at that time in use had originated with the medical chemists, and contained a multiplicity of unwieldy and unmeaning, and even absurd, terms. It had answered the purposes of chemists tolerably well while the science was in its infancy; but the number of new substances brought into view had of late years become so great, that the old names could not be applied to them without the utmost straining: and the chemical terms in use were so little systematic that it required a considerable stretch of memory to retain them. These evils were generally acknowledged and lamented, and various attempts had been made to correct them. Guyton's first unsuccessful attempt at nomenclature appeared in the issue for May 1782 of the *Journal de physique*. Being based on the phlogistan theory, which was then being exploded, it was violently criticised by Lavoisier, Berthollet and other chemists of Paris. Thereupon, he went to Paris to confer with them. After readjusting his views to the progressive school of chemistry at Paris, in conjunction with his once opponents he brought out in 1787, the *Methode d'une nomenclature chimique*, the principles of which were speedily adopted throughout Europe. This book and the *Elemens de chymie theorique et practique* (3 V. 1778) made him so famous that he was invited to contribute the chemical part of the *Encyclopedie methodique* (1786–92).

His Personality and His Honours

In the earlier years, his aggressive attempts to extract due recognition for scientific pursuits induced an antagonistic attitude in the mind of the public who were as yet far from conceding to the prerogatives of science. They accused him of "presumptuously disarming the hand of the Supreme Being". Once when their exasperation led them to destroy the lightning conductors which Guyton had put up at the Academy Buildings, the conductors could be saved from

vandalism only by a tactful assertion by the Secretary of the Academy that "the astonishing virtue of the apparatus resided in the gilded point, which had purposely been sent from Rome by the Holy Father." In spite of such early experiences, his life was crowned with honour and public recognition toward the end of his career. In 1796, he was made a member of the Institute. In 1803, he received the Cross of the Legion of Honour. In 1805, he was made an Officer of the same Order and in 1811, Napolean made him a Baron of the French Empire.

He died at Paris on January 2, 1816, full of age and full of honours.

Franchini, Pietro (1768-1837)

PIETRO FRANCHINI, the Italian priest and mathematician, was born on April 24, 1768, at Partigliano, near Lucca, in Italy. Though ordained a priest, he was for some time professor of philosophy at Rome and for a long time professor of higher mathematics in various places but mostly at Lucca. He is reputed to have been a mathematician of considerable power, having written several works on the various branches of the subject and a number of papers of some originality on analysis.

His Books

His first book entitled *Teorie dell' analisi* (3 V.) was published in Rome in 1792 and a supplementary volume appeared two years later. His *Trattato d' arithmetica* and *Memoria trigonometria* came out at Lucca in 1804 and 1808 respectively. Another considerable work in four volumes was published at Livorno in 1816 and 1817 under the title *La scienza del calcolo.* 1819 saw yet another book of his under the title *Elementi di algebra.*

His Papers

He published as many as sixteen learned papers in several Italian periodicals but chiefly in the *Atti della academ. Lucchese.* His first paper dated 1797 was *Sur la resolution des equations d' un degre quel conque,* while his last came out in 1835 under the title *Di alcuni problemi celebri.*

History of Mathematics

He also wrote three works on the history of mathematics, *viz.,* (1) *Seggio sulla storia mathematische* (1827); (2) *La storia della algebre et de' suoi principali scrittori* (1827); and (3) *Dissertazione sulla storia mathematica della antica nazione Indiana* (1830). The last-mentioned book, which was published in Lucca, should be of special interest to the readers of *Current Science.*

Franchini died at Lucca on January 26, 1837.

Macnish, Robert (1802-1837)

ROBERT MACNISH, the short-lived Scottish physician, was born in Glasgow on February 15, 1802. Medicine being the hereditary profession of his family, he obtained the M.C. degree of the University of Glasgow at the early age of eighteen. After a short practice at Caithness, he studied medicine at Paris for a year and eventually got his degree of M.D. at Glasgow in 1825. His research thesis, entitled *The anatomy of drunkenness,* was justly famous for its freshness and thoroughness. It was published in 1827. It enjoyed wide popularity for a long time, the third edition coming out in 1859.

Philosophy of Sleep

For some years he diverted his pen to the production of a variety of literary pieces, of which the fantastic fiction *Metempsychosis* marks the high watermark. After a prolonged illness which kept him from any serious work in 1829 and 1830, he published towards the end of the latter year his best known and most important work *The philosophy of sleep.* It was reputed to have been "a clear, lively, and well arranged account of the phenomena". About this time, he was greatly occupied with the epidemic of cholera and was one of the first to assert the contagious character of the disease.

Borderland of Psychology and Medicine

During the few years of his life that still remained, his interests definitely swerved to the borderland of psychology and medicine. His *Introduction to phrenology in the form of question and answer* came out in 1835. This book obtained great popularity, as many as ten thousand copies having been sold in a short time. In 1836 he edited Dr. Brigham's *On the influence of mental cultivation and mental excitement on health.*

His Personality

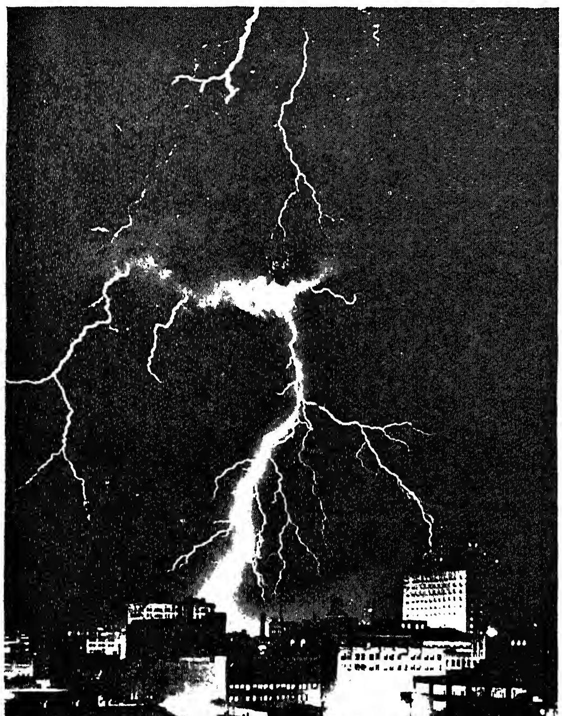
As a medical writer he displayed the graphic power of a delineator and as a man, he was one " who could not be known without being beloved ". While engaged on the revision of his *Introduction to phrenology* for a second edition, the epidemic of influenza counted him as one of its tolls on January 16, 1837.

Lightning Studies.

By Anna McNeil (*Scotia, N. Y.*).

SCIENTISTS turn their attention to the entire realm of Nature with the hope of harnessing mighty forces and making them subservient to man's use. Lightning in itself may not be tamed, but its cause is known, its action studied, its effects may be averted insofar as they disturb electrical transmission lines, and man has made artificial lightning in the great laboratories of industry and has caused it to strike and shatter objects that have been designated for the purpose.

It is estimated that an average of forty-four thousand thunderstorms takes place daily, the world over, and that the power of the lightning dissipated in these storms is equal to 1,200,000 kilowatts, or the glow of thirty million electric lamps of medium size.

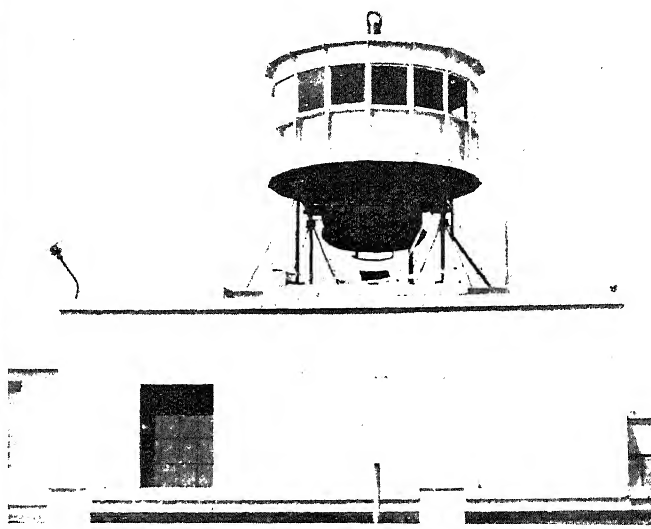


Lightning over Milwankee, Wisconsin, U.S.A.

One of the great lightning investigators was a Hungarian named Lenard. The descending drops and rising spray of a waterfall gave him a clue to the nature of lightning. He found that small drops of water are blown upward just as thunderheads are piled high by the wind. The small drops in the spray carry negative charges of electricity and large drops carry positive charges. He reasoned from this that the small drops of water that rise upward in a thunderhead are negatively charged while the larger drops that remain in the lower part of the cloud carry positive charges. The earth is charged negatively.

When the difference between the charge of the upper and lower parts of the cloud; between the lower part of the cloud and the earth; or between parts of one cloud and another, become too great, there is a flash of lightning with the accompanying rumble or crash of thunder. On transmission lines the flash may cause a sudden rise to as high as four or five million volts.

Lightning may pass from the earth to a cloud as well as from a cloud to the earth. When a tree is struck by lightning a current of great intensity is gathered up from the earth. It passes up the tree through the air and charges



Lightning Observatory, top of building 42, General Electric Co., Pittsfield Works. 102 ft. above ground, equipped with periscope, dark room, camera platform, and other devices. First building of its kind erected solely for observation of natural Lightning.

the cloud to the same potential as the earth. This explains why it is extremely dangerous to stand under a tree for shelter during a thunderstorm and why so many cattle are killed through being struck by lightning.

Until recently it was believed that lightning never strikes twice in the same place—in fact, there is a time honored proverb to that effect. But lightning not only strikes twice, but as many as ten times. This has been proved by a special type of camera in which the film is whirled past the lens at a faster speed than a mile a minute. There is a time scale along the length of the film so that readings in millionths of a second are possible. The ten re-current discharges from cloud to earth; earth to cloud; and so on,

alternately, occur in a fraction of a second, and at this inconceivable speed could not be detected by the human eye nor by an ordinary camera.

Farmers have observed that their crops grow better after an electrical storm and have attributed the fact to the rainfall which is apt to be heavy at such a time. Lightning is really the responsible factor. Scientists in the great fertilizer plants are lately uncovering one of Nature's age-long chemical secrets. Lightning produces one-hundred-million tons of nitrogen over the earth's surface every year, depositing it upon the soil to aid all growing things. A bolt of lightning coming down through the air which is composed of approximately four-fifths nitrogen and one-fifth oxygen, breaks down the chemical constituency of the air and bestows fixed nitrogen upon the land as a boon to the farmer, at no cost. Lightning thus serves a useful purpose and is a blessing in disguise, however terrifying its form.

For years the General Electric Company has experimented with artificial lightning and has produced ten million volts in the laboratory. Recently an outdoor lightning observatory believed to be the only one of its kind in the world, has been constructed 102 feet above ground, on the roof of the largest building of the Pittsfield, Massachusetts, General Electric plant.

The strange-looking structure is equipped with a periscope and a twelve-lens lightning recorder camera. Built largely of metal, it is grounded to the steel framework of the building on which it rests. It is coated with aluminum paint on the outside; with flat black on the inside. It is fourteen feet in diameter, topped by an eight-inch crystal sphere.

Lightning flashing in any direction within a radius of twenty miles is reflected on the silvery surface of the roof and thence in the crystal sphere and is made visible through the eyepiece of the periscope by a mirror set at an angle of 45 degrees, in its dark-walled tube.

The camera is directly beneath the periscope platform. It is exposed to the weather when in use but is protected with a curtain of compressed air. The compressed air is admitted into a perforated metal ring beneath which the camera is placed. The invisible curtain does not interfere with the taking of pictures and effectually keeps out all but the most severe downpour.

RESEARCH ITEMS.

Linear Diophantine Approximations.—Khintchine (*Math. Ann. B.*, **113**, 398–415) has contributed an interesting article about the solution of the non-homogeneous n-dimensional $[n > 1]$ diophantine approximation problem. The theorem of Kronecker, *viz.*, that given n irrational numbers $\theta_1, \theta_2, \ldots\ldots \theta_n$, then corresponding to every $t > 1$ we can find integers $x, y_1, \ldots\ldots y_n$ such that

$$(1) \quad |x\theta_i - y_i| < \frac{1}{t}, \quad i = 1, 2, \cdots n$$

and $0 < |x| \leqslant t^n$. Khintchine considers the non-homogeneous case, *i.e.*, when (1) is replaced by (2) $|x\theta_i - a_i - y_i| < \frac{1}{t}$, where a_i's are given real numbers. It is well known even in case $n = 1$, this problem is not solvable if the restriction on x is the same as above (or even when t^n is replaced by Ct^n). It was recognised by the author long ago that the theorem would only be true with some restriction on the irrational number θ. Ten years ago he found out the condition in case $n = 1$. The condition expressed in terms of continued-fractions is that the quotients of the continued-fraction-development of θ were bounded. It should be observed that if the contrary is true then the homogeneous problem for θ is solvable with much less restriction on x. [*i.e.*, $x = o(t)$ instead of $x = O(t)$.] The theorem he proves is the generalisation of this to higher dimensions. It should also be noted that generalisations of diophantine approximations to higher dimensions is often impossible or extremely complicated. As the author observes that the inequalities $|x\theta - y - a| < \frac{1+\epsilon}{\sqrt{5}\, x}$ is solvable for a sequence of values of x, and the analogue of this in the case of higher dimensions not being true. The extremely interesting result that he proves is the following:

Let $\theta_1, \theta_2, \ldots\ldots \theta_n$ be real numbers. The necessary and sufficient condition in order that a positive constant A exists satisfying the condition

$$o < x < At^n \; |x\theta_i - y_i - a_i| < \frac{1}{t}, \quad i = 1, 2, \cdots n$$

for all $t \geqslant 1$, is that there should exist another constant a (both the constants depend on the θ's such that the inequalities

$$o < x < At^n \quad |x\theta_i - y_i| < \frac{1}{t} \text{ does not possess a}$$

solution for any integral t.

The necessity of this follows easily by a method analogous to the one-dimensional case. The proof of sufficiency is extremely intricate.

K. V. I.

A Very Accurate Test of Coulomb's Law of Force between Charges.—Taking Coulomb's law of the force between two charges to be given by $F = \frac{\sigma\sigma'}{r^{2 \pm q}}$, Maxwell showed that $q < 1/21600$. This result quoted in all text-books gives the limit of accuracy of the inverse square law as determined by Maxwell and we have had to be satisfied with it till to-day. Now S. J. Plimpton and W. E. Lawton (*Phys. Rev.*, 1936, **50**, 1066) report experiments which prove that the exponent of r in the law of force differs from 2 by less than 1 part in 10^9. The electrostatic method of Maxwell and Cavendish was replaced by a quasi-static method in order to eliminate stray effects due to spontaneous ionization and contact potentials. The principle however is the same: A spherical air condenser consisting of two concentric insulated globes is employed. The upper globe has a small hole closed by a lid which has a projection making contact between the two globes. The outer globe is first charged to a high potential,

V, the lid is then removed by means of a silk thread and the outer shell being now earthed, the inner globe is tested for charge. If the inner shell has a potential less than v, $q < \frac{v}{V} F(a,b)$ where $F(a, b)$ is a quantity depending on the radii a, b of the spheres. In the present experiment the authors employed a galvanometer having a frequency of two cycles per second as the detector and placed it inside the inner globe so as to do away with contacts. The frequency was chosen low so as to eliminate induction effects. The outer sphere was charged to more than 3000 volts by means of a sinusoidal E.M.F. of 2 cycles per second produced by a "condenser generator". Since the galvanometer was thus used as a resonance instrument, the electromagnetic induction effects were not of any consequence and on account of the low frequency the fluctuations due to them were below the variations due to Brownian motion. The galvanometer was operated by a five stage resistance-capacity coupled amplifier designed for a frequency of about 2 c.p.s. and was observed through a conducting window in the outer sphere. In this way it was found that $v = 10^{-6}$ volt could be easily measured but there was no such potential shown by the galvanometer when the outer shell was charged. Hence the authors conclude that since $F(a, b)$ was 0·169 and $V > 3000$ volts and $v = 10^{-6}$ volt, $q < 2 \times 10^{-9}$.

A Mass-Spectrographic Study of the Isotopes of Argon, Potassium, Rubidium, Zinc, and Cadmium.—The isotopic analysis of K and Rb is important on account of its bearing on the problem of the radioactivity of these elements. Regarding A, Zn and Cd there is some discrepancy between different workers; particularly in Zn and Cd Stenvinkel and Svensson have reported the existence of some isotopes, *viz.*, Zn^{63} and Zn^{65} and Cd^{118} from a study of the band spectra of ZnH and CdH, while Aston does not obtain these isotopes. Now Alfred O. Nier has given the results of an investigation employing a mass-spectrograph of high resolving power (*Phys. Rev.*, 1936, **50**, 1041). His findings are:

A. A^{40}, A^{36} and A^{38} are present. $A^{40}/A^{36} = 325 \pm 4$ and $A^{36}/A^{38} = 5{\cdot}10 \pm 0{\cdot}07$.

K. K^{39}, K^{41} and K^{40} exist. $K^{39}/K^{41} = 13{\cdot}96 \pm 0{\cdot}1$ and $K^{40}/K^{39} = \frac{1}{8600} \pm 10\%$.

Rb. Rb^{85} and Rb^{87} were found. $Rb^{85}/Rb^{87} = 2{\cdot}68 \pm 0{\cdot}02$.

Zn.

Mass Number:	64	66	67	68	70
Percentage:	50·9	27·3	3·9	17·4	0·5

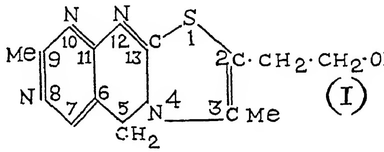
Zn^{65} and Zn^{63} were not found.

Cd.

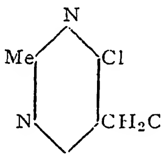
Mass Number:	116	115	114	113	112	111	110	108	106
Percentage:	7·3	0	28·0	12·3	24·2	13·0	12·8	1·0	1·4

Cd^{115} found by Aston is not confirmed and Cd^{118} was not observed. Making use of the isotopic constitution of K found by him the author concludes that K^{40} is the isotope responsible for the radioactivity of potassium, changing into Ca^{40}. In the case of Rubidium he considers that Rb^{87} is the active isotope changing into Sr^{87}, although the possibility of Rb^{85} being the active isotope is not entirely ruled out.

A Synthesis of Thiochrome.—Todd, Bergel, Frænkel-Conrat, and Jacob have recently described (*J. C. S.*, 1936, 1601) a synthesis of thiochrome (I), a yellow basic substance which is present in yeast, and which can be obtained from aneurin (Vitamin B_1) by oxidation with potassium ferricyanide in alkaline solution. (*Cf.* Peters, *Current Science*, 1936, **5**, 209.) Condensation of acetamidine with ethyl formylsuccinate gave *ethyl 4-hydroxy-2-methylpyrimidine-5-acetate*, from which by Curtius degradation 4-hydroxy-5-aminomethyl-2-methylpyrimidine was obtained; this yielded *4-hydroxy-5-hydroxymethyl-2-methylpyrimidine* with nitrous acid; the corresponding *chloro*-compound (II) was then obtained with phosphoryl chloride. 2-Amino-4-methyl-5-β-hydroxyethylthiazole (III*a* or III*b*) was synthesised from methyl α-chloro-γ-hydroxypropyl ketone and thiourea. Thiochrome was isolated from the resin obtained on heating a mixture of (II) and (III) at 110° for a short time.



(I)



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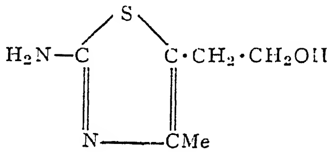
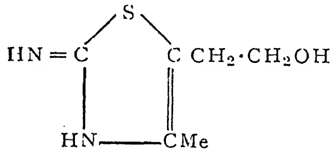


(III*a*)



(III*b*)

T. S. W.

Spermatogenesis of *Betta splendens*.—Fishes do not form such advantageous objects for germ-cell study as Amphibians do but *Betta splendens*, which has very few chromosomes for a Teleost and whose germ-cell elements are fairly large, offers good material. N. L. Bennington (*J. Morph.*, 1936, **60**, No. 1, December, p. 103) has studied the germ-cell origin and spermatogenesis in this animal. The following are his main observations: Residual spermatogonia larger than the normal spermatogonia persist along the walls of the lobules of the testis and give rise periodically to primary spermatogonia. The diploid chromosome number is 42, two of which are supposed to be sex chromosomes. During the division of the primary spermatocyte, the sex chromosome lags behind on the spindle. It is concluded that *Betta* is a form where the sex chromosomes are not very greatly differentiated from the autosomes. But no genetic evidence for the sex chromosomes is offered in the animal.

Growth and Division in Specialised Tissues.—Interesting data are afforded by A. Cohen and N. J. Berrill (*J. Morph.*, December 1936, **60**, No. 1, 243) on the methods of growth and division in specialised tissues in vertebrates. In the notochord for instance, it is only the non-vacuolated cells at the posterior tip and the periphery that divide. Vacuolated cells never divide. In the retina it is only the non-specialised cells occurring at the periphery that undergo division. The specialisation which progresses from the periphery to the centre marks the end of all cell division. The cells of the gut epithelium also divide by mitosis but during division a round shape is assumed by the cells and all functional activity stops. Fully formed cartilage cells divide both by mitosis as well as amitosis. It is concluded that the ability of functional cartilage cells and cells of the gut epithelium to divide is due to their comparatively simple structural differentiation as opposed to notochordal and retinal cells where specialisation has been carried so far that division is impossible.

SCIENCE NOTES.

Royal Asiatic Society of Bengal.—At the ordinary monthly meeting, held on the 4th January, an important contribution on *the Alimentary Canal of* Epilachna Indica (*Coccinellidæ: Coleoptera*), *with a discussion on the Activities of the Mid-gut Epithelium*, was read by S. Pradhan.—'On a comparative study of the alimentary canals of carnivorous and herbivorous beetles of the family Coccinellidæ (Coleoptera), it was seen that there were a large number of both structural and physiological peculiarities in the case of *Epilachna Indica* which are important from the view-point of digestion among insects in general. The alimentary canal of another species of *Epilachna*, *i.e.*, *E. Corrupta*, has already been described by two American workers, Potts (1927) and Burgess (1932), but their accounts have differed from each other. In this paper the author has presented the results of his investigations on *E. Indica*.''

At the same meeting Messrs. Narendra Chandra Vedantatirtha (*Calcutta*) and Maulvi Shamsuddin Ahmad (*Calcutta*), were balloted for as ordinary members.

* * *

The Second Annual Meeting of the Indian Academy of Sciences, was held on the 11th, 12th and 13th January 1937, Rajāsabhabhushana Sir C. V. Raman, Kt., F.R.S., N.L., presiding. The Inaugural ceremony was held at Sir Puttannachetty Town Hall on the 11th, when Mr. S. G. Forbes delivered an address. Two public lectures were arranged during the session one on the 11th by Sir C. V. Raman on 'Recent Advances in Astronomy and Astrophysics' (illustrated by lantern slides) and the other on the 12th by Prof. K. S. Krishnan on 'The Approach to the Absolute Zero of Temperature'.

Thirty papers under Section A and seven under Section B, were communicated for the Scientific meeting.

A visit was arranged on the 13th instant to the Tobacco Factory, Cleveland Town. The visitors were shown round by the management, and the several processes from the tobacco to the finished product ready for the market, were explained.

The following scientists have been elected Honorary Fellows of the Academy.

(1) Prof. Max Born; (2) Sir Henry Dale; (3) Dr. Irving Langmuir; (4) Prof. P. Niggli; (5) Prof. R. W. Wood.

British Association.—The Annual Meeting of the British Association will be held next year in Nottingham on September 1–8 under the presidency of Sir Edward Poulton. The following sectional presidents have been appointed.—Section A (Mathematical and Physical Sciences), Dr. G. W. C. Kaye; B (Chemistry), Dr. F. L. Pyman; C (Geology), Prof. L. J. Wills; D (Zoology), Prof. F. A. E. Crew; E (Geography), Prof. C. B. Fawcett; F (Economics), Prof. P. Sargant Florence; G (Engineering), Sir Alexander Gibb; H (Anthropology), Dr. J. H. Hutton; I (Physiology), Dr. E. P. Poulton; J (Psychology), Dr. Mary Collins; K (Botany), Prof. E. J. Salisbury; L (Education), Mr. H. G. Wells; M (Agriculture), Mr. J. M. Caie.—*Nature*, **138**, No. 3502, 1004.

* * *

The Effect of Annealing Procedure on the Tensile Properties of Arsenical Copper Bar. By E. F. G. Gilmore.—(*Bulletins of Indian Industrial Research*, 1936, No. 3).—This paper gives the results obtained in a series of tests carried out with a view to ascertain the effects of (*a*) annealing temperature and conditions, (*b*) period of annealing under constant conditions, (*c*) size of test pieces, upon the tensile properties.

A short description is given of the construction of the annealing furnace through which either steam or nitrogen could be passed continuously. The preparation of the test pieces and their characteristics are also described.

It was found that constant conditions of annealing were obtained by heating for not less than 60 minutes at 750° and for 120 minutes at 650°. Longer periods of annealing had no effect on the process. Further, the properties of the specimens annealed at the lower temperature were more satisfactory. No differences in the tenslie stress were observed in the experiments employing steam or nitrogen, but the specimens heated in steam remained comparatively bright while those heated in nitrogen were tarnished a dull brown. The steam method is therefore recommended for general practice. K. R. K.

* * *

Report of the Forest Products Research Board for the year 1935. (His Majesty's Stationery Office. Price 2*s*.)—The work described includes investigations on the physical, seasoning and fire-resistant properties and the working qualities of timbers, both home-grown and

imported, as well as on their chemical composition, durability and preservative treatment. The value of the work can be gauged by the increasing use made of it by industry, which is also described in the *Report*. The *Report* cannot fail to be of interest to all those concerned in any form with timber.

* * *

Lightweight Concrete Aggregates.—(His Majesty's Stationery Office. Price 4*d.*)—There is a considerable demand for lightweight concrete aggregates in building. This Bulletin describes the various materials—pumice, furnace clinker, coke breeze, lightweight slag, expanded clays, shales and slate—that are at present available for this purpose. The properties of the concretes made with these aggregates are indicated, and recommendations are given with regard to special points to be considered in specifying concrete mixes of lightweight aggregates for various uses.

* * *

Corrosion of the Tin-Plate Container by Food Products.—(His Majesty's Stationery Office. Price 1*s.*)—The corrosion of the tin-plate container by food products is still the basic problem of the canning industry.

Considerable practical progress has been made since 1931, and it now seems likely that the problem will eventually be solved by the improvement of lacquers and methods of lacquering; but this is not yet certain. It is therefore hoped that this second report, which describes experiments that throw further light on the factors involved in the corrosion of tin-plate and discusses the application of the results in commercial practice, will be of assistance to the industry. It is also hoped that it may be of interest to those who are concerned with the wider problem of corrosion in general.

* * *

Under the auspices of the National Geographic Society and the Smithsonian Institution, an expedition bound for the Jungles of Sumatra, has been organised to " bring back alive " wild animals of the "*Far East*" and to collect geographic and natural history information and photographs. The animals brought back will go to enrich the collection in Washington's famous Zoo. Dr. William M. Mann, Director of the National Zoological Park, will lead the expedition.

Accompanying Dr. Mann will be Mrs. Mann; a member of the National Geographic Society's photographic staff, and Roy Jenier and Malcolm Davis of the Zoo staff. The party will sail from Seattle, and after brief pauses in Japan, the Philippines and Singapore, will establish headquarters at some place on the Netherlands island of Sumatra, near the sea and in easy reach of "wild country". In the expedition's baggage will be a number of special " mercy traps " and a few special cases in which to carry small, delicate creatures. The heavy traps and cages needed for the larger jungle beast will be built in the field.

The region to be visited is at present only poorly represented by animals in the National Zoological Park. Dr. Mann feels, he will confer with game officials and naturalists in the countries to be visited, and will collect whatever he can of the missing specimens. Mammals, reptiles, birds, and a few fishes will be the primary objects of the collectors, but in spare time, Dr. Mann hopes also to collect insects and even a few botanical specimens.

After the work is completed in Sumatra, the expedition expects to visit the Netherlands island of Ceram, almost 2,000 miles to the east, and possibly some of the East Indies islands not under Netherlands Jurisdiction. Before starting home, the party will also visit Bangkok, Siam.

* * *

Announcements.

Journal of the Bombay Natural History Society.—The Honorary Secretary announces that with effect from 1st January 1937, a uniform rate of Rs. 5 per copy has been fixed for all back numbers of the Journal from Vol. I to Vol. 35 inclusive. Intending purchasers may apply to the Honorary Secretary, Bombay Natural History Society, 6, Appollo Street, Bombay (India).

* * *

Under the chairmanship of Gustave Fassin, of the Bausch and Lomb Scientific Bureau, Rochester, New York, a committee has been appointed to secure and arrange exhibits for the first **International Exhibition of Applied and Scientific Photography** ever held in the United States.

According to plans revealed by Mr. Fassin and Rowland S. Potter, National Chairman of the Scientific and Technical Section of the *Photographic Society of America* and President of the local section of the Society, which is sponsoring the exhibition, the exhibition will be held in the Rundell Memorial Building at Rochester, New York, in March 1937. This new and beautiful civic building has exceptional facilities for showing both pictures and apparatus.

Scientists all over the world are being contacted in an endeavour to make the exhibition fully representative of the many fields of applied and scientific photography. Scientists in any of the following fields are invited to send exhibits to the heads of the sections listed below, or to C. B. Neblette, Secretary of the Scientific Section at Rochester, who will supply entry blanks.

Dr. Walter Clark—Astronomy, meteorology, light sensitive substances.

Mr. Gustave Fassin—Photomicrography, microphotography, metallography.

Dr. Brian O'Brien and Dr. Walter Clark—X-Ray Spectrography.

Dr. T. R. Wilkins—Cosmic ray photography and theoretical physics.

Mr. C. B. Neblette—Press photography.

Mr. Glenn Matthews—High speed photography.

Mr. Rowland S. Potter and Mr. John W. McFarlane—Technique of color photography.

Mr. John W. McFarlane—Photography by invisible radiation.

Mr. Glenn Matthews—Aerial photography.

Secretary, C. B. NEBLETTE, F. R. P. S., *Rochester Athenæum and Mechanics Institute, Rochester, New York.*

We acknowledge with thanks receipt of the following :—

"The Agricultural Gazette of New South Wales," Vol. XLVII, No. 12, December 1936.

"Indian Journal of Agricultural Science," Vol. VI, Part V, October 1936.

"Monthly Bulletin of Agricultural Scienc 'nd Practice," Vol. 27, No. 10, October 1936.

"Journal of Agriculture and Livestock in India," Vol. VI, Part VI, November 1936.

"The Philippine Agriculturist," Vol. XXV, No. 7, December 1936.

"Journal of the Royal Society of Arts," Vol. LXXXIV, Nos. 4383–4388.

"The Calcutta Review," Vol. 61, No. 3, December 1936.

"Chemical Age," Vol. 35, Nos. 908–912.

"Journal of Chemical Physics," Vol. 4, No. 12, December 1936.

"Berichte der Deutschen Chemischen Gesellschaft," Vol. 69, No. 12,

"Russian Journal of General Chemistry," Vol. VI, No. 9.

"Journal de Chimie Physique," Vol. 33, No. 11.

"Experimental Station Record," Vol. 75, No. 5, November 1936.

"Transactions of the Faraday Society," Vol. XXXII, Part 12, December 1936.

"Indian Forester," Vol. LXIII, No. 1, January 1937.

"Indian Forest Records," Vol. II, No. 1, Entomology: A Survey of the Damage to Teak Timber by the Beehole Borer, throughout the Main Teak-bearing Forests of Burma.

"Forschungen und Fortschritte," Vol. 12, Nos. 34, 35/36.

Government of India Publications :—

"Monthly statistics of production of certain selected industries of India" (Department of Commercial Intelligence and Statistics). No. 6, September 1936.

"The New Statistical Tables Based upon Fisher's t." By M. Vaidyanathan, Bulletin No. 13.

"Indian Trade Journal," Vol. CXXXIII, Nos. 1590–1594.

"Annual Report of the Public Health Commissioner for 1934," with the Government of India Vol. I.

"Marriage Hygiene," Vol. III, No. 2, November 1936.

"Scripta Mathematica," Vol. IV, No. 2, April 1936.

"Journal of the Indian Mathematical Society," Vol. II, No. 4, 1936.

"The Calcutta Medical Journal," Vol. 31, No. 6, December 1936.

"Medico-Surgical Suggestions," Vol. 5, No. 12, December 1936.

"Review of Applied Mycology," Vol. 15, No. 11, November 1936.

"Carnegie Institution of Washington, News Service Bulletin," Vol. IV, No. 9.

"Report of the Fuel Research Board for the year ended 31st March 1936."

"Annual Report on the Working of the Tea Districts Emigrant Labour Act (XXII of 1932) for the year ending 30th September 1935."

"Agriculture and Animal Husbandry in India", 1933–34 and 1934–35, Part I, 'Crop Production.'

"Zoologisch Botanischen Gesellschaft in Wien", Bands—LXXIII, LXXIV/LXXV, LXXVI, Hefts 1–4, LXXVII, Hefts 1–4, LXXVIII, Hefts 1–4, LXXIX, Hefts 1–4, LXXX, Hefts 3–4, LXXXI, Hefts 1–4, LXXXII, Hefts 1–4, LXXXIII, Hefts 1–4, LXXXIV, Hefts 1–4.

"Journal of the Bombay Natural History Society," Vol. 39, No. 1.

"Nature," Vol. 138, Nos. 3499–3503.

"Journal of Nutrition," Vol. 12, No. 5, November 1936.

"Canadian Journal of Research," Vol. 14, Nos. 10 and 11.

"Science and Culture," Vol. II, Nos. 6 and 7.

"Lingnan Science Journal," Vol. 15, No. 4, November 1936.

"Scientific American," Vol. 155, No. 6; Vol. 156, No. 1.

Catalogues:

"Monthly list of books on Natural History and Science," December 1936. (Messrs. Wheldon and Wesley, Ltd., London.)

ACADEMIES AND SOCIETIES.

Indian Academy of Sciences:

December 1936. SECTION A.—M. BORN AND N. S. N. NATH: *The Neutrino Theory of Light.—II.* CH. V. JOGA RAO: *An Optical Investigation of Some Indian Oils. III.—Intensity of the Scattered Light.*—The light scattered by the the oils has a a genuine molecular origin, and is subject to the usual laws of molecular scattering in dense media. H. GUPTA: *On a Conjecture of Ramanujan.* P. SURYAPRAKASA RAO AND T. R. SESHADRI: *Reactivity of the Double Bonds in Coumarins and Related α-β Unsaturated Carbonyl Compounds. Part III.—Action of Mercuric Acetate on Coumarinic and Coumaric Acids and Esters.* M. K. PARANJPE: *The Convection and Variation of Temperature near to a Hot Surface. Part II. Applications of Interferometry to the Measurements of Temperatures and Temperature Gradients Very close to a Hot Surface.*—Details of method and various precautions to be taken are discussed. S. CHOWLA: *On a Relation between Two Conjectures of the Theory of Numbers.* I. CHOWLA: *The Number of Solutions of a Congruence in Two Variables.* S. RAMA SWAMY: *The Structure of Thin Metallic Films.*—The structures have been studied by electron diffraction, and evidence has been obtained for the existence of gold and silver in the amorphous state. R. S. KRISHNAN: *X-Ray Diffraction and Electrolytic Dissociation.—Sulphuric Acid and Sulphates.* The change in the character of the halo with progressive dilution of pure sulphuric acid is followed. B. Y. OKE: *Lattice-Theory of Alkaline Earth Carbonates. Part IV.—Elasticity Constants of Calcite.* K. L. RAMASWAMY: *Refractive Indices and Dispersions of Gases and Vapours. Substituted Methanes and Ethane, Cyclopropane, Ethylene Oxide, and Benzene.* M. A. GOVINDA RAU: *The Dipole Moment and Structure of Pyrones.*—2.6 *Dimethyl-*

γ-Pyrone, Xanthone, and Coumarin. The observed moments are explained on the basis of the various excited and unexcited states in resonance.

December 1936. SECTION B.—L. A. KRISHNA IYER: *The Primitive Culture of Travancore.* M. A. H. QADRI: *Male Genitalia of Mallophaga Infesting North-Indian Birds.*—The Male Genitalia of some of the important forms belonging to Amblycera and Ischnocera have been described. PRAKASH CHANDRA JOSHI: *Some Phases of the Life-History of Two Tibetan Caryophyllaceæ*—Arenaria musciformis *Wall. and* Thylacospermum rupifragum *Schrenk.*—The available stages in the development of the male and female gametophytes of the two plants and the structure of the seed of the latter have been described. BENI CHARAN MAHENDRA: *A Case of Polymely in the Indian Bull-Frog* Rana tigrina *Daud.*—A complete description of the external features of the specimen has been provided together with an account of the correlated abnormalities in the muscular, skeletal and nervous systems. L. A. KRISHNA IYER: *Anthropometry of the Primitive Tribes of Travancore.*—Additional evidence is provided for the existence of a Negrito strain in the aboriginal population of South India.

The National Academy of Sciences, India:

December 21, 1936.—R. N. GHOSH: *On a Simple Derivation of Stresses in a Moving Fluid.* L. S. MATHUR: *Infra-red Absorption Spectrum of Tin-di-iodide.* L. S. MATHUR: *Determination of Latent Heats of Vapourisation of the Selenides of Cadmium and Mercury and Telluride of Zinc from the Absorption Spectra of Their Vapours.* B. N. SIN·H: *The Prevention of Rots in Tomatoes with Esp· al Reference to the Mould's Attack.*

·alcutta Mathematical Society:

December 20, 1936.—N. N. GHOSH: *A Note on the Solution of a System of Linear Equations.* S. GHOSH: *On Some Two-Dimensional Problems of Elasticity.* M. DE DUFFAHEL: *Sur Certains Systemes d'Equations dux Differences Totales.* M. DE DUFFAHEL: *Sur la Generalisation du Probleme de Dirichlet et sa Solubilite.*

Meteorological Office Colloquium, Poona:

November 3, 1936.—Dr. K. J. Kabraji.—"The condensation of water in the atmosphere" [based on Bennett's paper on the subject (*Q. J. Roy. Met. Soc.*, 1934) and on cognate researches of H. Kohler].

November 10, 1936. Dr. L. A. Ramdas.—"Some problems of solar and atmospheric radiation."

November 24, 1936. Dr. S. K. Pramanik.—"Bergeron's paper on the physics of cloud and precipitation."

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Benares Hindu University:

Annual Meeting of the Court.—

At the Annual Meeting of the Court held last month the following office-bearers were elected:—

Chancellor: Major-General His Highness Maharajadhiraj Raj-Rajeshwar Narendra-Shiromani Maharaja Shri Sir Ganga Singhji Bahadur, G.C.S.I., G.C.I.E., G.C.V.O., G.B.E., K.C.B., LL.D., A.D.C., Maharaja of Bikaner. *Pro-Chancellors:* (1) Major His Highness Raj-Rajeshwar Sir Umed Singh Bahadur, G.C.I.E., K.C.S.I., K.C.V.O., Maharaja of Jodhpur. (2) His Highness Maharaja Sir Aditya Narain Singh, K.C.S.I., Maharaja of Benares. *Pro-Vice-Chancellor:* Raja Jwala Prasad, B.A., C.E., M.I.E. (India). *Treasurer:* Rai Govind Chand, M.A., M.L.C.

Faculties.—

At the Annual Meeting of the Faculties the following Deans were elected:—

Faculty of Arts: Prof. Gurmukh N. Singh, M.Sc. (London), Bar-at-Law. *Faculty of Science:* Prof. P. K. Dutt, M.A. (Cantab.). *Faculty of Technology:* Dr. N. N. Godbole, B.Sc., M.A., Ph.D. (Berlin). *Faculty of Law:* The Rt. Hon'ble Dr. Sir Tej Bahadur Sapru, Kt., P.C., LL.D. *Faculty of Oriental Learning:* Mahamahopadhyaya Pandit Pramathnath Tarkbhushan. *Faculty of Ayurveda:* Mahamahopadhyaya Kaviraj Dr. Gananath Sen, M.A., M.D., L.M.S. *Faculty of Theology:* Pandit Vidyadhar Gour.

Research.—

Pandit Raj Bali Pandey, M.A., a research scholar, submitted a thesis on *the Origin, Significance and History of Hindu Sanskaras* which was sent for valuation to three external examiners—Prof. A. B. Keith, Dr. Ganganath Jha and Mr. P. V. Kane. The reports of the examiners being unanimously favourable, the Faculty of Arts recommended to the Senate that the Degree of Doctor of Letters be conferred on Pandit Raj Bali Pandey.

The University has vigorously pursued the policy of undertaking research work related to the industrial needs of the country. Out of nine prizes awarded by the Industrial Research Council of the Government of India the University secured three prizes—the second, the third and the fifth. The second prize was awarded to Dr. V. S. Dubey, D.Sc. (London), and Prof. M. B. Rane, M.A., for working out a process for the manufacture of sulphuric acid from Gypsum. The third prize was won by Dr. V. S. Dubey and Mr. P. N. Agrawal, M.Sc., for their work on the substitution of soda ash by an Indian rock in glass manufacture. The fifth prize was awarded to Mr. Sadgopal, M.Sc., for his valuable work on the aromatic resources of India.

University of Mysore:

1. *Examinations.*—

The Pre-Medical, (I) M.B.B.S. and (II) M.B.B.S. examinations were held in December 1936.

2. *Extension Lectures.*—

The following extension lectures in Kannada were delivered:—

(*a*) Mr. H. K. Ramiengar, M.A., Assistant Director of Industries and Commerce, Bangalore, on "Village or Rural Industries", at Nanjangud.

(b) Dr. K. N. Venkatasubba Sastry, M.A., Ph.D., F.R.Hist.S., Assistant Professor, Maharaja's College, Mysore, on "The History of Mysore Administration", at Tumkur and Kolar.

3. *Deputation to congresses and conferences.*—

Mr. E. G. McAlpine, M.A., Dip.Edn., V.D., J.P., Principal, Central College, Bangalore, presided over the Annual Conference of the Mysore State Education League held in December 1936, at Chikmagalur.

Mr. A. R. Wadia, B.A., Bar-at-Law, Professor of Philosophy, Maharaja's College, Mysore, also attended the Conference.

Dr. M. H. Krishna, M.A., D.Litt., Professor of History, Maharaja's College and Director of Archæological Researches in Mysore, presided over the Historical Conference and Mr. B. M. Srikantia, M.A., B.L., Professor of English, Central College, Bangalore, presided over the Literary Conference held at Hampi in December 1936, in connection with the Vijayanagar sexcentenary celebrations.

The following other members of the teaching staff of the University were deputed to attend the conferences and congresses as noted :—

(i) Mr. K. B. Madhava, M.A., A.I.A., Professor of Mathematical Statistics and Economics, Maharaja's College, Mysore—The Twentieth Annual Conference of the Indian Economic Association, Agra.

(ii) Mr. L. Rama Rao, M.A., F.G.S., Professor of Geology, Central College, Bangalore—The Indian Science Congress, Hyderabad.

(iii) Mr. B. R. Subba Rao, M.A., Lecturer, Intermediate College, Mysore—The Twentieth Annual Conference of the Indian Economic Association, Agra.

(iv) Mr. G. Hanumantha Rao, M.A., Lecturer, Maharaja's College, Mysore—The Indian Philosophical Congress, Delhi.

(v) Mr. N. S. Narayana Sastri, M.A., Lecturer, Maharaja's College, Mysore—The Indian Science Congress, Hyderabad.

4. *Recognition of Examinations (M.B.B.S.).*—

Intimation has been received from the Director of Examinations, Royal College of Surgeons in England, London, that candidates who are able to produce the schedule of certificates of study required for admission to the Primary F.R.C.S. examination completed and signed by the University of Mysore will be admissable to the Primary Examination for the Fellowship of the Royal College of Surgeons in England.

The Central Advisory Board of Education:

The problem of educational reconstruction and unemployment was again the main subject of deliberation before the Central Advisory Board of Education which met recently in Delhi, as it was at its first meeting held in December, 1935. According to a Press note issued by the Director of Public Information the Board had under consideration the recommendations made by the Unemployment Committee, United Provinces, 1935. Certain recommendations of this Committee regarding University education, on which the Government of India also felt that it would be advantageous to obtain the views of the local Governments in order that they might be placed before the Board for consideration, related to—

(a) the raising of fees charged in Universities;

(b) the prescribing of limit to admission of students to Universities;

(c) the content of education as given in the Universities, *i.e.*, the need of greater stress on scientific and vocational education;

(d) the system of co-ordination between different Universities so as to secure uniformity of standards and prevent unhealthy competition;

(e) the setting up of an Advisory Grants Committee to advise the Ministry of Education in regard to the grants which are made to the Universities for research work; and

(f) the sending of students overseas for further education.

The entire subject was again considered by the Board, particularly in regard to unemployment amongst the educated classes and the importance of obtaining reliable statistics. After a general discussion the Board decided that the views of the Inter-University Board should first be obtained on the recommendations relating to University Education, and the matter be then discussed further by the Board.

It may be remembered that when last year the Board had before it for consideration the problem of educational reconstruction and unemployment, it passed a series of resolutions, suggesting a radical reform of the system of secondary education, so that apart from providing instruction which would lead to Universities and to professional colleges, the system might have stages at the end of which students could branch off either to private occupations or to vocational schools. As it was of vital importance that such a scheme should be well devised and should afford an effective substitute for a purely literary type of education, the Board had stated that expert advice would be of value in organizing a scheme of reconstruction. This suggestion of the Board was accepted by the Government of India. After consulting the local Governments the Government of India were able to obtain the services, during this cold weather, of two experts—Mr. Abbott, late Chief Inspector of Technical Schools, Board of Education, London, and Mr. Wood, Director of Intelligence, Board of Education and Ministry of Health, London. Unfortunately, because of the shortness of time, it was not possible for the Government of India to obtain an adequate number of experts for a simultaneous survey of educational problems throughout India. Within the time allotted, Messrs. Abbott and Wood will probably only be able to make detailed recommendations in regard to the Provinces of Delhi, the Punjab and the United Provinces. If they have time they may be able to visit Bengal and Bombay also.

ERRATUM.

Vol. V, No. 6, December 1936, Page 295.
Note entitled "On the Constitution of Ayapin".—1st line *for* "ayapin" *read* "ayapanin".

1943-36.—Printed at The Bangalore Press, Bangalore City, by G. Srinivasa Rao, Superintendent, and Published by B. N. Sastri, M.Sc., A.I.C., A.I.I.Sc., for the "Current Science" Board of Editors, Indian Institute of Science, Hebbal Post, Bangalore.

CURRENT SCIENCE

Vol. V] February 1937 [No. 8

CONTENTS.

The Indian Institute of Science—II.

In the editorial published in the last number of this Journal, we endeavoured to provide our readers with a historical background of the evolution of the Indian Institute of Science, which, however meagre, was considered necessary for a proper appreciation of the principal recommendations of the Irvine Committee. We felt that, without such a perspective, the general public might place undue emphasis on the critical and exciting observations on "the circumstances of the Institute" which thickly mantle the more important and fundamental sections of the Report. Reperusing the Committee's report we are led to form the opinion that the Irvine Committee have presented a document which really embodies the results of investigation belonging to two unrelated committees, *viz.*, The Enquiry Committee and the Reviewing Committee. This fact gives it all the piquancy of interest which the publication of the Report has stimulated in the public mind.

The more we read this interesting document, the deeper is our conviction that the Committee did not strictly adhere to the terms of reference to them, *viz.*,

> "To review the working of the Institute with special reference to the purposes for which it was founded and, if any changes are considered desirable in the organisation or activities of the Institute for the better achievement of these purposes, to make recommendation accordingly, but with due regard to the Institute's actual or reasonably augmentable financial resources."

If the Irvine Committee had treated the Institute from an impersonal standpoint, and had only confined their investigations to matters relating to the equipment of the laboratories, departmental researches, their general interest to pure and applied science,

their scope and direction of expansion, competence of the personnel and other academic and financial problems, their report would have been an invaluable contribution. Whether the reflections on other subjects included in the report lend additional weight and value to the scheme outlined by the Committee is doubtful.

We propose briefly to review the critical and constructive sections of the Committee's Report.

The "circumstances," whatever their nature and extent, which prevailed in the Institute immediately preceding the assembly of the Committee, and which, in our opinion, the Governing Council by virtue of their inherent powers should have controlled, without passively exposing their cumulative effect to the serious comments of an external body, must be at least partly due to efforts at introducing internal reforms and readjustments; and their very ephemeral character must render them too insecure a foundation for basing permanent and far-reaching proposals for the advancement of the academic interests of the Institute. That the "atmosphere" and "circumstance" of the Institute greatly influenced the judgment of the Committee is manifest from their remark that "in the present circumstances our recommendations become the more emphatic in order that the Institute may be saved from disintegration." If the recommendations have really such vitality as to preserve the Institute from putrefaction, then the high note of confidence expressed by the Committee is irreconcilable with the somewhat pessimistic key of the concluding sentence of the report, *viz.*, "if our scheme fails, it can only be through the clash of personalities beyond the remedy of any powers possessed by a Reviewing Committee." This spirit of diffidence should be foreign to recommendations based absolutely on the stern academic demands of the Institute.

The report makes certain observations which, not based on facts, unfortunately tend to weaken the effectiveness of the general recommendations. We shall deal with a few of them.

In their Proposals for economising the financial resources, the Committee observe that

"The hostels would be more economically managed if the post of the Warden were abolished, and the students took into their hands the control of messing arrangements under the general supervision of one of the senior resident members of the staff."

The Sewell Committee writing on the same subject deplored that

"The post of the Hostel Warden being left vacant was subsequently abolished."

The fact is the post has been non-existent for several years.

The main thesis of the report which is really of some importance, is that the Institute has from the beginning devoted all its resources and energies towards developing purely theoretical investigations, and has practically ignored its capacity for lending effective assistance to the advancement of industries. To readers of the Irvine Committee Report, who have no access to relevant literature, the remark that

"applied research has been handicapped from the beginning because no organised contact exists between the Institute and the world of industry."

must necessarily give an erroneous and misleading impression, for the industries in India have not developed in a measure comparable with those of the Western countries, and further, repeated references to them by the authorities of the Institute have elicited the reply that there were few scientific problems encountered by them for solution. However, few will dispute the desirability of such a contact, but all may not agree that the want of it imposes a handicap. We have to remember that so long as the primary function of the Institute is to train students in methods of research, the subjects selected should necessarily have an instructional value. It seems to us that while keeping this function in the foreground, the authorities of the Institute have also borne in mind the possible application of the results of such an enquiry to the inception of new industries and the improvement of the existing ones. In a booklet published in 1924 when the Indian Science Congress held its Eleventh Annual Session in Bangalore, Sir Martin Forster has recounted in detail the principal activities of the Institute in the field of applied science, and these achievements form an impressive record. The list is too big to be transcribed here. Within the last few years as the result of experimental work conducted at

the Institute. The Porcelain Factory has come into existence. It is true that spectacular results revolutionising industrial methods have not been produced by the Institute, and it is extremely doubtful whether they would have been achieved, even if an intimate contact with the world of industry had been established. If India should become a competitor with other Western countries as the producer of industrial goods, and if she is to achieve economic independence, the greatest need is to encourage and promote fundamental research and there should be one foundation entrusted with the responsibility of prosecuting and directing academic enquiries, and at the same time should be able and willing to undertake investigations of problems in applied science initiated by its professors or referred to them by industrial bodies.

Another instance of a statement not founded on facts is the allegation that, " The reduction in the allotments for the other departments has seriously curtailed their activities " and it is suggested that this state of affairs has resulted from " the Director's policy to make the Institute a centre of physical and mathematical studies." In expressing disapproval of this policy the Committee point out that these subjects offer an attractive field for speculation and experiment and have no direct contact with industry. There are three elements in this criticism. Regarding the bearing of academic researches on the development of industries, Professor M. N. Saha is reported to have said in his recent address at Hyderabad that,

> "In this country the criticism is being made that the Universities were doing only academic work. If they neglected this work (Physics) for industrial research, they would be neglecting their duties, the effect of which will be seen in the falling of the standard and efficiency in the industrial work itself."

The Irvine Committee make the suggestion that

> " The creation of the new department of Physics at the time when the financial resources of the Institute were diminishing, has had the inevitable effect of withdrawing from the other departments a certain proportion of the allotments that had hitherto been available for them". Thus "the reduction in the allotments for the other departments has seriously curtailed their activities."

We have examined the annual reports of the Institute with a view to discover the truth of this serious criticism, and we are afraid that with the information we have been able to collect from these authoritative publications, we cannot agree with the observations of the Committee. In the first place, the Committee in Part III of their Report, have taken the actual expenditure for 1934–35 for comparison with the revised budget for 1935–36, and the disparity in figures should be accounted for by circumstances such as the late appointment of certain professors and the failure of others joining their posts, internal transfers, the proceeding of a few to appointments elsewhere and the general cutting down of grants owing to financial stringency. Even assuming that it is permissible to compare the actuals of one year with the revised estimates of the succeeding year, then according to the figures quoted by the Committee, the Departments of Electrical Technology and General and Organic Chemistry have suffered to the extent of Rs. 1,08,510 and the gain on the part of the department of Physics is Rs. 33,842. If this amount is distributed among the three oldest departments which have been building up their equipment and receiving increments to their staff for over twenty years, then each department would have contributed 10 per cent. of its allotment for assisting the newly created Physics department to provide itself with the necessary apparatus and staff. The spirit of mutual co-operation in times of financial depression is commendable. Further even supposing that the three departments should not have been deprived of the small percentage of their grants, has this rendering of help " seriously curtailed their activities " ? We give below the number of publications issued by each department for the five years covered by the Irvine Committee Report.

	30-31	31-32	32-33	33-34	34-35
1. Electrical Technology ..	1	2	7	1	15
2. General Chemistry ..	7	2	2	7	10
3. Organic Chemistry ..	10	6	11	7	14
4. Biochemistry ..	25	11	12	33	49
5. Physics ..	..	..	..	..	39

The year in which the withdrawals of allotments from other departments are seriously animadverted upon by the Committee happens to be one of unprecedented activity in each department. This creditable and remarkable output of work from

the other departments must be due to the spirit of emulation created by the newly founded department of Physics.

We shall now deal with some of the more important recommendations of the Committee.

The essential part of the re-organisation proposed by the Committee is the appointment of a Registrar whose duties have been indicated in clear terms. The Pope and Sewell Committees recognised the need of the appointment of a Registrar, and made suitable recommendations, but so long as the Director was not also the head of a Department, the appointment was deferred. As the present Director is entrusted with the responsibilities of developing a new department which must necessarily absorb all his time and energy, any measure for relieving him of the routine office duties must be welcome to him. The Committee emphasise that the responsibilities of the Registrar "can be carried out only by a man of mature experience, trained in the official administration." We fail to see the importance of the stress laid on administrative experience, for the previous Directors who were carrying on administrative duties with conspicuous ability were eminent laboratory experts, and we are of opinion that a man possessing an intimate knowledge of the scientific activities in general and of the state of scientific advancement in India in particular, together with an acquaintance with research work carried on in technological and industrial Institutions, would be better qualified not only to deal intelligently with all the scientific matters pertaining to the Indian Institute, but also "to restore harmony in the administration and a feeling of confidence in the staff". We further feel that a most suitable candidate for this post could have been secured, if the Governing Council had been permitted to act in accordance with the Regulations governing the appointment of superior officers, without the Committee invoking the direct intervention of the Government of India.

One of the outstanding academic reforms suggested by the Committee which, in their opinion, would come nearest to fulfilling the intentions of the Founder of the Institute is the creation of "a strong representative school of Chemistry capable of playing a significant part in pure and applied researches" with Chairs in five divisions of the department. The head of this new department of Pure and Applied Chemistry—the synthesised product of the existing General and Organic Chemistry departments,—is to be an Organic Chemist "of recognised eminence, acquainted with and interested in the technical applications of Chemistry", directing researches in organic chemistry, physical chemistry, inorganic and mineral chemistry, technical chemistry and pharmacological and medicinal chemistry, and receiving a maximum salary of Rs. 2,000 from the commencement of his service. A proposal of this magnitude and impracticability has been accepted with its financial obligations by the Governing Council, and approved by the Government of India. In order to provide for the appointment of the head of the new department and for five assistant professors, each on a salary of Rs. 800, the Irvine Committee have proposed a revised draft budget based on their proposals of effecting economies. Any one perusing the figures of this budget, on the basis of which the future budgets of the Institute are likely to be prepared, would be tempted to quote the very sentence of the Committee with very slight alteration, "the creation of the new department of Pure and Applied Chemistry at a time when the financial resources of the Institute were diminishing has the inevitable effect of withdrawing from the other departments a large proportion of the allotment that had hitherto been available for them". In making proposals for the re-organisation of the Chemistry Department, the Committee could not have remembered their criticism of the Physics Department to which they have unwittingly exposed themselves. We feel diffident about the practicability of the new scheme, and we would prefer the existing departments to retain their individual existence with professors at the head of each department. In order to defray the cost of their proposals of administrative re-organisation and academical reform, the Committee have formulated certain measures of economies which seem to us singularly unfortunate. These measures include suspensions, abolitions and replacement of posts and reductions of emoluments under eight categories. Out of the savings thus effected the appointment of a Registrar, a Professor of Organic

Chemistry and five Assistant Professors is to be financed. The Committee may have succeeded in framing a balanced budget, but are the authorities of the Institute also sure that the means suggested towards that end will secure contentment, harmony and cheerful co-operation among the members of staff affected by retrenchment? A casual perusal of the annual reports of the Institute will convince any reader that the contributions made by the senior assistants are quite as voluminous and valuable as those made by the Professors. They occupy positions of trust and responsibility in the department. The sudden change of their official designation and the drastic reduction in their remuneration by more than forty-four per cent. must tell adversely on the efficiency of the departments, and after all, the harder part of the departmental activities must ultimately devolve on the senior assistants, all of whom are entrusted with the duty of instructing the students and training them in the methods of research. The suggestion of reducing the provision for travelling expenses will undoubtedly diminish the opportunuties of the Director establishing contact with the industrial research centres, and prevent the Professors and other members from attending scientific conferences. The Pope and Sewell Committees have emphasised the importance and necessity of the Director touring in India for the purpose of securing co-ordination of the work of the Institute with that of the official and semi-official research institutions and of disseminating information concerning the activities of the Institute, and the Professors and their assistants would, by attending the periodic scientific gatherings and industrial conferences, expound, as part of their legitimate duty, their own researches and receive information regarding the lines along which co-operation could be established. The proposal of reduction in expenses under printing and stationery must unfavourably react on the size and number of instalments of the Journal, which is at present the only organ announcing to the world of science the important results obtained in the scientific departments of the Institute, but the Committee is apparently not disturbed even if there is a fall in the number of publications, for they observe "few publications are likely to result from such (industrial) research work, but this need not be deplored".

We have pursued a line of thought not quite in conformity with that of the Irvine Committee in framing their scheme, but that does not diminish our warm and sincere appreciation of the candour and forcefulness with which they have urged their recommendations. It must be remembered that the situation which confronted them rendered their task both delicate and difficult, and none could have achieved the work more thoroughly or more enthusiastically.

The phrase "the benefit of India" occurring in the Scheme for the Administration of the Institute connotes a deeper significance to us than merely material welfare of India. The greatest benefit that the Indian Institute of Science can confer on India is, in the first instance, to preserve peace, harmony and trustful co-operation among the members of staff and students, which according to the Irvine Committee Report were almost on the verge of extinction, and in the second place the members of staff should be an inspiring example to the students of those qualities which distinguished Michael Farady and Louis Pasteur. If Science is synonymous with Truth, then the Indian Institute of Science should be the greatest and most responsible official expositor of Truth. In a recent address which Sir Venkata Raman gave at the Prize Distribution Ceremony of a local educational institution, he is reported to have observed that

> "the true wealth of the Nation was in the rising generation. Their character, their cheerfulness and the courage with which they assayed the task of life depended very much on the kind of training they received and, surely, producing this human wealth was a great industry."

Sir Venkata Raman's stewardship of the Institute will be finally judged by the care and assiduity with which he fosters this "industry" and by the zeal and sincerity with which he inculcates the sanctity of "character" in the minds of the young men who pass through his hands.

The Irvine Committee have produced a report embodying the results of patient investigation, some of whose recommendations are bound to be puzzling, while a few others must necessarily be in conflict with those of their predecessors, obviously because the Committees did not pursue a continuous policy, and did not develop a co-ordinated unitary scheme.

The Institute is now favoured with a large number of authoritative reports, each defining its aims and objects and each proposing recommendations for its improvement independently of the other. We have read these reports and all the available relevant literature, and we cannot resist the conclusion that all these documents should be carefully studied by a special section of the Governing Council which, working in a peaceful atmosphere, could evolve a more practical scheme for the academic administration of this great foundation, inaugurating a ten-year plan of development, as far as possible in conformity with the spirit of the recommendations of the previous committees.

Our proposal to subject all the reports for a general and comprehensive review by a Sub-Committee of the Council is to enable the authorities to discover the greatest common measure of agreement underlying the recommendations of the reviewing and special committees, which should form the basis of the scientific policy of the Institute for the next ten years. In close collaboration with the heads of different departments, and in consultation with the external bodies suggested by the Irvine Committee, this Sub-Committee ought to be able to draw up a programme of laboratory work for the same period, without in any way curtailing the freedom of the professors to initiate new lines of research or to prosecute and direct those now in progress. If the intention of the Government of India in appointing a reviewing committee is not to permit the recommendations of this body to rescind those of the previous committees, then it is obvious that a harmonious synthesis of the best and the most acceptable sections of all the reports may prove a fruitful field on which the Institute may profitably expend its money and labour. The divergence in the view-point as well the strongly-held antithetical recommendations of the different committees must be a sufficient justification for the proposal we have made, and the opinions expressed by them regarding the economies to be practised by the Institute, the reorganisation of the chemistry departments, the establishment of competent professorial chairs and the allocation of duties to the Registrar, differ so fundamentally, that further and more comprehensive examination of all the various schemes may be necessary and desirable before practical steps are taken to implement any set of recommendations. The important problem of augmenting the financial resources of the Institute has not been seriously discussed in any Report, and the equally important question whether the Universities, which enjoy the privilege of returning a representative to the Council, are not to be invited to contribute an annual grant to the Institute, and whether in recognition of such contribution these academic institutions are not also to enjoy the privilege of selecting their best scholars for further work in the different departments, must engage the consideration of the Sub-Committee. The feasibility of this scheme, which in our opinion will tend to establish a more sympathetic and closer co-operation between the Institute and the Universities, so desirable in the general interest of the progress of science in India, depends almost entirely upon the confidence which the Universities have that "the Institute would do what no other Institution can do". Such confidence and co-operation entail "that the chairs in the Institute should be filled by men of the highest eminence, irrespective of nationality" and for this purpose the Sewell Committee recommended that the terms of appointment to the Directorate and Professoriate be made sufficiently favourable to attract such men.

We have not the least hesitation in thinking that the essence of the Irvine Committee Report is that the Institute must be ethically pure and scientifically great, and we emphasise that the need and responsibility of upholding the moral purity of this great foundation : re even greater than promoting its academic achievements.

The Silver Jubilee of H. E. H. The Nizam.

WITH a fortnight of rejoicing Hyderabad is celebrating the Silver Jubilee of the reign of her ruler, His Exalted Highness Sir Osman Ali Khan Bahadur.

The changes that have come over the State of Hyderabad since the present ruler assumed the reins of government are at once important and far-reaching. Ethnically and otherwise the Dominion of the Nizam was a singular composite of elements varying greatly and differing in certain respects from other native states, when His Exalted Highness ascended the throne. The Nizam, who recognized early enough the advantages accruing to his state from direct personal administration, effected radical changes in the then-existing form of government. The discriminating judgment exercised by the Nizam in the choice of statesmen like the Right Hon'ble Sir Akbar Hydari to fill positions of trust and responsibility, has been an invaluable asset to the State, and Hyderabad to-day holds the proud and unique record, that the great depression, which affected nearly every country in the world, was powerless, against the superior devices of her statesmen, to check the tide of her swelling revenues.

Foremost among his peers of the Princely Order in India, both as a sagacious administrator and as an experienced statesman, the interests of his subjects have ever been nearest the Nizam's heart. During the past quarter of a century of his rule the most notable improvements in the State have always had a direct bearing on the economic and social amelioration of his subjects. The Nizam who is well known for his ascetic simplicity, severely whittled down all expenditure connected with the pageantry of the Jubilee, and has recommended, that the funds should be used for schemes of rural uplift and provision of health clinics. The foundation of the Osmania University, on the lines of the most advanced educational centres of the West, is but one instance of the zeal of His Exalted Highness to further the cause of higher education in the State. The interests of the ryots have not been neglected in this multi-phased progress. Numerous irrigation projects are being undertaken and the translation into action of the faith that can move a mountain has culminated in the impounding of river water at Hussiensagar. Amidst this rapid advance in the material welfare of the people of Hyderabad, the Nizam has not lost sight of their spiritual betterment and the religious rituals form the most important part of the Jubilee festivities.

It can scarcely be otherwise than appropriate to recall here the solemn pledge given by the Nizam on the eve of his accession—"It is my highest ambition to be in all respects, both to the Government of India and to my own people what my late father was; a friend on the one hand and a beneficent ruler on the other." To what extent he has redeemed this pledge the present State of Hyderabad bears eloquent testimony.

Studies on Polyploid Plants.

Triticum-Haynaldia Hybrids with Special Reference to the Amphidiploids *Triticum dicoccum* × *Haynaldia villosa*.

By D. Kostoff and N. Arutiunova.

(*Institute of Genetics, Academy of Sciences of USSR, Moscow.*)

GENUS *Haynaldia* has been used for intergeneric hybridization with the genus *Triticum* by several investigators. Hybrids have been produced with representatives of *vulgare*—and of *durum*—group, all being highly self-sterile. The hybrids set seeds very rarely when flowering free in the field, but somewhat more when pollinated with a third species or with the *Triticum* parent. Tschermack[1] (1929), however, obtained in the subsequent generations a fully fertile hybrid from the cross *Tr. turgidum* ($2n = 28$) × *Haynaldia villosa* ($2n = 14$). The cytological studies of this hybrid showed that it is an amphidiploid plant with 56 somatic chromosomes[2] (Berg, 1934).

During the last few years we crossed and studied a series of double and triple hybrids, as well as allopolyploids produced in crossing *Triticum* species with *Haynaldia villosa*. We produced a large number of F_1 — *Tr. dicoccum* × *Haynaldia villosa*, and several plants of the cross combination *Tr. vulgare* (Novinka) × *Haynaldia villosa*. The majority of the spikes of these hybrids bloom free, while some of them were crossed back to the parental species or pollinated with pollen from a third species. From the seeds thus obtained we grew two plants in 1935 and fifteen plants in 1936.

Fig. 1.

Spikes. From left to the right: (1) *Haynaldia villosa*, (2) Hybrid *Triticum Timopheevi* × *Haynaldia villosa*, (3) *Tr. Timopheevi*, (4) Hybrid *Triticum dicoccum* × *Haynaldia villosa*, (5) *Tr. dicoccum*, (6) Hybrid *Triticum vulgare* × *Haynaldia villosa*, (7) *Triticum vulgare*.

The plants grown in 1935 resulted from free blooming of the F_1 — hybrid *Tr. dicoccum* × *Haynaldia villosa*. One of them had 42 somatic chromosomes, while the other one had 28 somatic chromosomes. Both plants were self-sterile. The former plant has probably resulted from a cross pollination of the hybrid (*Tr. dicoccum* × *Haynaldia villosa*) with *Tr. vulgare*. The female gamete obviously has not been reduced, containing complete chromosome sets from *Tr. dicoccum* ($n = 14$) and *Haynaldia villosa* ($n=7$); the hybrid being a hexaploid one and having all chromosomes from three different species, namely, *Tr. dicoccum*, *Tr. vulgare* ($n = 21$) and *H. villosa*. It was self-sterile.

In 1936 we grew one plant from the cross (*Tr. dicoccum* × *H. villosa*) × *Secale cereale* ($n = 7$). The hybrid has 28 somatic chromosomes and represents a trigeneric hybrid which has all the chromosomes from *Tr. dicoccum*, *H. villosa* and *S. cereale*, *i.e.*, 14÷

[1] Tschermak, E., "Ein neuer fruchtbarer Weizenbastard (*T. turgidum* × *T. villosum*)", *Forsch. auf d. Geb. d. Pflanzenbaus u. d. Pflanzenzüchtung Festschr. Rümker*, P. Parey, Berlin, 1929.

[2] Berg, H. K., "Cytologische Untersuchungen an *Triticum turgidovillosum* und seinen Eltern", *Zeitschr. für ind. Abst. u. Vererbgsl.*, 1934, **67**, 342-373.

7 ÷ 7 = 28[3] (see Kostoff and Arutiunova, 1936). Another cross combination represented: (*Tr. dicoccum* × *H. villosa*) × *Tr. Timopheevi* ($n = 14$). We grew seven hybrids from this cross combination. Six of them were real triple hybrids, while one was an amphidiploid *Tr. dicoccum* × *H. villosa*, originating probably apomicticly. Five of the triple hybrids had 35 somatic chromosomes, *i.e.*, 14 from *Tr. dicoccum* ÷ 7 from *H. villosa* ÷ 14 from *Tr. Timopheevi*. They have obviously originated from unreduced egg cells fertilized with normal gametes from *Tr. Timopheevi*. One plant of the triple hybrids had 32 somatic chromosomes. It has probably originated from an egg cell having not a complete somatic chromosome number but only 18 chromosomes and a normal sperm cell from *Tr. Timopheevi*. The triple hybrids had almost an intermediate appearance between the component parental species and are highly sterile. In the I metaphase of the reduction division most frequently 9 univalents and 13 bivalents were found, but tri- and tetravalents were also seen. Two more amphidiploid plants were produced from the hybrid (*Tr. dicoccum* × *H. villosa*) when the F_1-hybrids bloom free in the field together with other plants, without isolation.

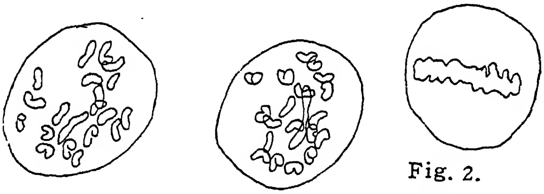


Fig. 2.

Meiosis in *Triticum dicoccum* × *Haynaldia villosa*, hybrid. First two pollen mother cells having each one a single bivalent chromosome with terminal chiasma. Third cell—second metaphase—all chromosomes being in one plate (failure of the first meiotic division). This condition leads to formation of gametes with somatic chromosomes number.

Amphidiploid *Tr. dicoccum* × *Haynaldia villosa* has completely normal pollen (98% viable). During the reduction division we have found usually 21 bivalents or 20 bivalents and 2 univalents. In exceptional cases more than two univalents were seen. Reduction division proceeds usually quite normal but irregularities were also found. The univalent chromosomes seem to be the chief cause for these irregularities. They were found outside of the I metaphase plate or on the equatorial plain during the I anaphase. Occasionally II metaphases with 21 ± 1 chromosomes were seen. In certain cases the univalents remain on the spindle even during the I telophase. They are probably responsible for some of the irregularities during the second division.

In a few cases one univalent divided during the first division. This also leads, no doubt, to certain irregularities in the second division. It is very probable that the chromosomes (perhaps the majority) lagging on the spindles during the second division represent halves of univalent (or univalents) which have divided during the first division. Most frequently, however, the univalents split only during the first division and probably divide during the second one.

The tetrads formed after the second division are usually equal. The laggards on the spindle during the second division form in certain cases micronuclei, but such cases were rarely observed. We studied several hundreds of PMC in tetrad stage (aceto-carmine preparations) and saw only a few such cells. Counting 63 PMC in tetrad stage—62 had normal tetrads and only in one PMC one pentad was seen (four large microspores and one very small).

Amphidiploid *Tr. dicoccum* × *Haynaldia villosa* seems to have relatively normal reduction division in the embryo-sac too, because the plant is fully fertile.

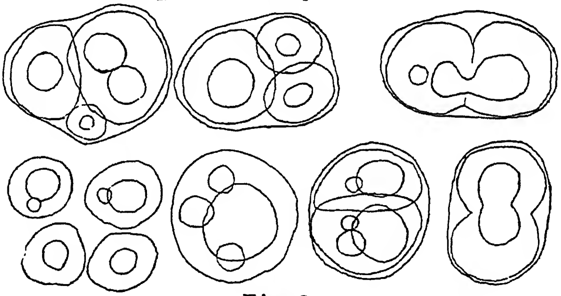


Fig. 3.

Tetrad stage in the hybrid *Triticum dicoccum* × *Haynaldia villosa*.

Crossing F_1 (*Triticum vulgare* × *Haynaldia villosa*) with *Tr. vulgare* two plants were obtained, both having ca. 48–49 somatic chromosomes. They have probably originated from fusions of unreduced egg cells with normal *Tr. vulgare* sperm cells, *i.e.*, 21 *vulgare* ÷ 7 *villosa* ÷ 21 *vulgare* = 49 somatic chromosomes. The reduction division of one of these plants was studied in aceto-carmine preparations and about 7 univalents and 21 bivalents were observed.

Finally one plant with 40 somatic chromosomes was obtained in crossing F_1 — (*Tr. dicoccum* × *H. villosa*) with *Tr. Timopheevi*. This plant has probably originated when a normal sperm cell of *Tr. Timopheevi*

[3] Kostoff, D., and Arutiunova, N., "Studies on polyploid plants XIV. The behaviour of *Haynaldia* genom

A Photoconductive Photometer—A New Method and Apparatus for the Quantitative Estimation of Chlorophyll.

By B. N. Singh and N. K. Anantha Rao.
(*Institute of Agricultural Research, Benares Hindu University.*)

ATTENTION has not infrequently been drawn to the need for a simple method of estimating chlorophyll, since chlorophyll is so closely related to plant metabolism, its chemical composition and area, and is influenced by such factors as light, temperature and manurial treatment. The study of the various aspects of the rôle of chlorophyll in plant life, demands a method of its determination which shall be applicable to small quantities of material, open to minimum error, reasonably simple and quick enough to enable a large number of quantitative estimations to be made at a time and be of general application for work on chlorophyll.

The generally employed spectrometric methods are neither speedy nor practicable for a considerable number of determinations. Moreover, the conversion from the original extract produces errors much too large for experimental purposes. Although the colorimetric methods possess many advantages, certain imperfections do exist, the elimination of which appears to be desirable. Every separate test by comparison demands the existence of a standard solution. Standard solutions are, however, a source of recurring trouble not only because of the inconvenience involved in their preparation, but also for many other reasons, including their lack of permanence, disparities of colour and so forth. This precaution should be strictly observed in chlorophyll estimations since chlorophyll is known to decompose even in the dark. The colorimetric method is more accurate at lower concentrations while the spectrometric is more accurate at higher concentrations.[1] Recently Oltman,[2] has developed a simple method using a photo-electric cell. The method, while useful in many respects, suffers from certain disadvantages. The difference in accuracy between high and low concentrations is great. The loss of light in the solvent and on the cell windows is not compensated. Being a direct method it has the obvious disadvantage of lack of sensitivity.

To circumvent the defects inherent in the earlier methods, the following method and apparatus has been developed in this laboratory and has been in use for some time.

The principle essentially consists in determining the amount of light absorption of an alcoholic extract of plant pigments within a narrowly defined region of the spectrum, for which the chlorophylls possess a marked absorption, while the absorption of the other pigments is infinitesimal.

Concentration of substances in solution are determined by absorption measurements depending upon Lambert-Beer law, "The extinction coefficients (E) at equal stratum thickness bear the same proportion to each other as the concentrations (C) of the dissolved substances" consequently $E_1 : E_2 = C_1 : C_2$ or $C_2 = C_1 \frac{E_2}{E_1}$. The concentrations are easily determined when once a series of measurements are recorded *in the same region of the spectrum*, on a suitably graduated range of solutions having known concentrations. In an alcoholic extract (80% methyl alcohol) of green plant tissue containing flavones, chlorophyll ($\alpha + \beta$), carotin and xanthophyll, the pigments exhibit certain definite absorption characteristics. The chlorophylls are unique in possessing a marked absorption in the red region for which the absorption of the others is infinitesimal. The carotenoids possess a marked absorption in the blue for which the absorption of the chlorophylls is little. The concentration of the chlorophyll or the carotenoids (total) can be determined in the above extract quite independently of each other provided that only those spectral filters are employed whose transmission ranges correspond to the infinitesimal absorption of the components in solution. Independent investigations (to be described elsewhere) have shown that the transmission in red from the above extract is a true measure of chlorophyll concentration and that it is unaltered by the yellow pigments (Fig. 1).

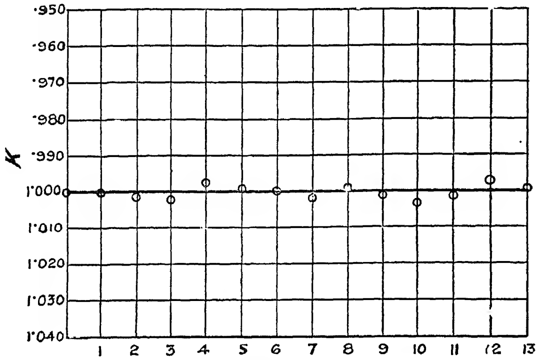


Fig. 1.

Drops of Carotenoids added.
Stratum Thickness 30 mm.

Extinction coefficient values (K) obtained from a solution of chlorophyll (in 80% methyl alcohol), to which an alcoholic extract of carotenoids has been added in increasing proportion.

The apparatus is represented diagrammatically in Fig. 2. The source of light L supplies two equal beams of light. Two absorption cells V_1 and V_2 of equal stratum thickness* are interposed in the path of the light one on each side. During experimentation one of them is filled with the alcoholic extract and the other with the pure solvent. By this arrangement the loss of light in the solvent and on the cell windows is compensated. The transmitted lights from the absorption cells pass through the red spectral filters F_1 and F_2 (transmission 6200–6800 Å) and fall on the two selenium cells S_1 and S_2 mounted *in vacuo*, where the effect of radiation appears as an increase in conductivity of the cells. The change of conductivity is proportional to the transmitted light. Compensating device which converts direct reading into null-method is employed; the balance being effected by adjusting the lights that alter the currents by changing the conductivity of the selenium cells. The circuit is essentially of the bridge type, G being a sensitive galvanometer. The differences if any in the two cells are eliminated by the use of the common battery and shunted by R.

The selenium cell is specially selected on account of its maximum sensitivity, constancy and quickness of response to radiation and *its linear response with illumination in the spectral region employed.*

* To be determined according to the experiment.

For making an estimation the absorption cells are first removed and the light adjusted to equal intensity, as indicated by the null-point.† Now the pigment extract is put in one absorption cell and the solvent in the other. More light is transmitted by the latter, which throws the bridge out of balance and is indicated by the deflection of the galvanometer. In front of the absorption cells are the light apertures Lo_1 and Lo_2 (→←) whose opening can be measurably varied by the arrangement shown in Fig. 2*b*. The amount of opening is indicated by the degree of turning of W. This directly gives the value of the transmitted light as a percentage of the incident. By gradually diminishing the light on the side of the solvent, the transmitted lights are adjusted to equal intensity as indicated by the null-point. The measurement should be repeated interchanging the absorption cells V_1 and V_2 and the average value taken. This compensates any variations in wall thickness of the absorption cells. From the value obtained the extinction coefficient is extracted and the concentration determined.

The following are some of the data obtained by the above method in an investigation on the effect of temperature on chlorophyll formation in etiolated seedlings of *Pisum sativum*.

TABLE I.

Mgms. of chlorophyll per unit weight of material.

Temperature	Time				
	1st hour	2nd hour	3rd hour	4th hour	5th hour
10° C.	0	0	0	0	4
15° C.	0	0	0	7	9
20° C.	0	0	8	10	13
25° C.	0	9	11	13	21
30° C.	0	10	13	15	19
35° C.	0	0	10	12	14
40° C.	0	0	0	2	4

The suitable range of temperature for the formation of chlorophyll seems to be 20° C.—35° C. in the example studied.

† For obtaining this R may be used as a fine adjustment.

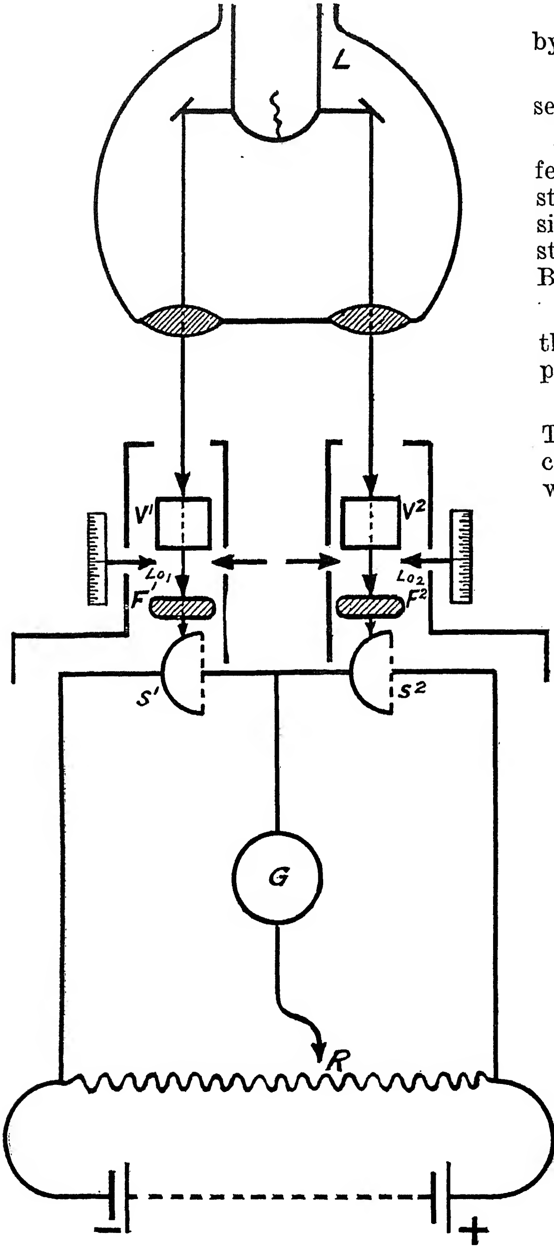


Fig. 2*a*.

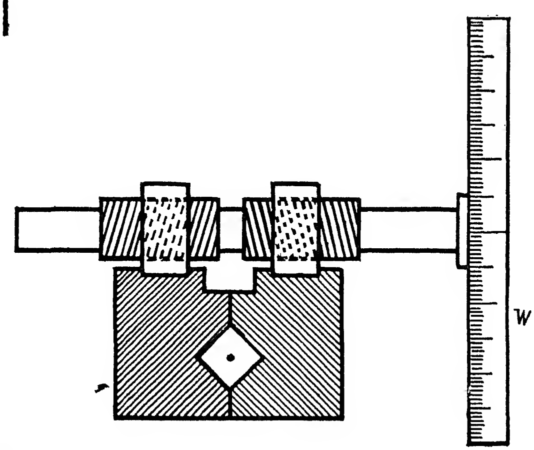


Fig. 2*b*.

The special advantages of the procedure over the earlier ones are :

1. The estimations are quick as the laborious process of separation of pigments is eliminated.

2. The transmission values are arrived at by exact physical measurements.

3. The null method is more accurate and sensitive than direct reading methods.

4. Accuracy can be maintained for different concentrations by change of the stratum thickness of the absorption cells, since the transmission is dependent upon stratum thickness according to Lambert-Beer law.‡

5. The loss of light in the solvent and on the windows of the absorption cells is compensated.

The accuracy of the method is ± 2·0%. The various details as to construction, calibration and methods of experimentation will appear elsewhere.

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‡ The transmission values should be converted to unit thickness.

1. Shertz, F. M., *Plant Physiology*, 1928, **3**.

2. Oltman, R. E., *Plant Physiology*, 1933, **8**.

LETTERS TO THE EDITOR.

The Median as a Statistic.

AN impetus to the use of the median in statistical analysis has undoubtedly been given in recent years by P. R. Crowe.[1, 2, 3] In justifying some of the rules he has given, Crowe has either appealed to intuition or assumed normality of distribution. As can be seen from below *we can deduce some rules which are entirely independent of the frequency distribution in the population from which our sample was obtained.*

Suppose we have a sample of n values and we wish to know the median of the population from which that sample was obtained. We proceed as follows.

By definition, the median of a population is such that the chance of obtaining at random from that population a value which is either greater or less than the median is $\frac{1}{2}$.

Hence the chance of obtaining in a random sample of n values from that population not more than l values which are less than the median is given by

$$P = \frac{1}{2^n}\left(1 + {}_nC_1 + \ldots . + {}_nC_l\right)$$
$$= I_{\frac{1}{2}}\,(n - l,\, l + 1) \quad .. \quad (1),$$

where $I_{\frac{1}{2}}\ (n - l,\ 1 + 1)$ is an incomplete β-function ratio written after the manner of K. Pearson.[4]

For a given value of P and n, equation (1) can be solved for l.* Let us choose some limit for random chance, say 5%. We put $P = 0{\cdot}05$ in (1) and solve for l. In general we will get two values of l differing by unity such that the values of P corresponding to these two values of l will be on either side of $0{\cdot}05$. We choose l_1, the smaller of the two values.

Let us arrange the n values of our sample in the ascending order of magnitude thus :

$$y_1,\ y_2, \ldots . y_{l_1}, \ldots . y_{n+1-l_1}, \ldots . y_n.$$

It is clear that if म,† the median of the population from which our sample was obtained, is equal to or less than y_{l_1}, the chance is less than $0{\cdot}05$ of obtaining from that population a random sample of n values in which there are not more than l_1 values below म, that is to say, on our limit of 5% for random chance our sample could not have been obtained from a population

* The method of solution will be given in a fuller paper which will be published elsewhere.

† The word मध्यम means middle or central in Sanskrit. We will thus use the first letter म to denote the value of the median in the population. म is pronounced like *me* in calmer.

in which म is equal to or less than y_{l_1}. Thus $\text{म} > y_{l_1}$.

In a similar manner we can show that on the same limit for random chance म is less than $y_{n_1+1-l_1}$.

$$\text{Thus } y_{l_1} < \text{म} < y_{n+1-l_1} \quad .. \quad \text{(i)}$$

Now the y's are measured correct to a certain number of significant digits. We increase y_{l_1} and decrease y_{n+1-l_1} by unity in the last significant digit. Let the values thus obtained be denoted by y'_{l_1} and y'_{n+1-l_1} respectively. We can now rewrite (i) as

$$y'_{l_1} \leqslant \text{म} \leqslant y'_{n+1-l_1} \quad .. \quad \text{(ii)}$$

Since the limits y'_{l_1} and y'_{n+1-l_1} were obtained on the 5% limit for random chance, we well term them the 5% limits, and the interval from y'_{l_1} to y'_{n+1-l_1} the 5% interval.

In deducing (i) and (ii) we have assumed that

$$y_{l_1} < y_{l_1+1} \text{ and } y_{n-l_1} < y_{n+1-l_1}$$

If, however, $y_{l_1} = y_{l_1+1}$ and $y_{n-l_1} = y_{n+1-l_1}$, it can be easily seen that (i) and (ii) will have to be replaced by

$$y_{l_1} \leqslant \text{म} \leqslant y_{n+1-l_1} \quad .. \quad \text{(iii)}$$

In a similar manner we can obtain the interval on any other limit for random chance.

Suppose for the sake of definiteness we use 5% as our limit for random chance. Then our tests of significance may be stated thus:

(1) The median of a random sample is significantly different from zero if the 5% interval for it does not contain zero.

(2) The medians of two random samples are significantly different from each other if the 5% intervals for them do not have a common part.

We shall apply these tests to the example given on page 113 of R. A. Fisher's book.[5]

(*a*) Suppose the drugs were given to the same patient. Then we must use the last column in the table on page 113 of (5). Arranging the values in the ascending order of magnitude we get

$0 \cdot 0$, $+0 \cdot 8$, $+1 \cdot 0$, $+1 \cdot 2$, $+1 \cdot 3$, $+1 \cdot 3$, $+1 \cdot 4$, $+1 \cdot 8$, $+2 \cdot 4$, $+4 \cdot 6$. The median is $+1 \cdot 3$.

Since $n = 10$, we find on the 5% limit for random chance that $l_1 = 1$. Hence y_{l_1} and y_{n+1-l_1} are $0 \cdot 0$ and $+4 \cdot 6$; and so y'_{l_1} and y'_{n+1-l_1} are $+0 \cdot 1$ and $+4 \cdot 5$. Thus the 5% interval is from $+0 \cdot 1$ to $+4 \cdot 5$.

Since this interval does not contain zero we see that the *median* of the series is significant. Fisher, using "Student's" *t* test in which normality of distribution is assumed, finds that on the 5% limit for random chance the *mean* of the series is significant.

(*b*) Suppose the drugs were given to twenty different people. We must, in this case, use the columns under 1 (Dextro —) and 1 (Lævo —) separately. Arranging the values in the ascending order of magnitude, the two series are

(*a'*) $-1 \cdot 6$, $-1 \cdot 2$, $-0 \cdot 2$, $-0 \cdot 1$, $0 \cdot 0$, $+0 \cdot 7$, $+0 \cdot 8$, $+2 \cdot 0$, $+3 \cdot 4$, $+3 \cdot 7$.

(*b'*) $-0 \cdot 1$, $+0 \cdot 1$, $+0 \cdot 8$, $+1 \cdot 1$, $+1 \cdot 6$, $+1 \cdot 9$, $+3 \cdot 4$, $+4 \cdot 4$, $+4 \cdot 6$, $+5 \cdot 6$.

The 5% interval for (*a'*) is $-1 \cdot 5$ to $+3 \cdot 6$, and that for (*b'*) is $0 \cdot 0$ to $+5 \cdot 5$. Since these two intervals have a common part we conclude that the two medians are not significantly different from each other on the 5% limit for random chance. Using the *t* test, Fisher finds that the means of the two samples are not significantly different from each other on the same limit for random chance.

Advantages of the median over the mean in tests of significance.—

(1) The tests given above are far simpler than those in which the mean is used.

(2) For any test in which the mean is used it is essential to know (or to assume) the distribution in the population, whereas such a knowledge is not required in the case of the median.

The paper, in which the use of the median as a statistic is discussed in more detail, is under preparation and, as mentioned above, will be published elsewhere.

S. R. SAVUR.

Poona 5,
January 15, 1937.

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[1] P. R. Crowe, *Scott. Geog. Mag.*, 1933, **49**, 73-91.

[2] H. A. Mathews, *Scott. Geog. Mag.*, 1936, **52**, 84-97.

[3] P. R. Crowe, *Geographical Review*, 1936, **26**, 463-484.

[4] K. Pearson, *Tables of the Incomplete β-Function*, The "Biometrika" Office, University College, London.

[5] R. A. Fisher, *Statistical Methods for Research Workers*, 1932, 4th edition.

Raman Spectrum and Constitution of the $(NO_3)^-$ Ion.

THE Raman spectra of inorganic nitrates in the crystalline state as well as in aqueous solutions have been studied by a number of workers.[1] Krishnamurti[2] examined by the powder technique the spectra of a large number of crystalline nitrates, some in the anhydrous condition and others as hydrates. In all cases, he found an intense Raman line near about 1050 cm.$^{-1}$ while two other fainter lines near about 720 and 1360 cm.$^{-1}$ were also present in the spectra of certain nitrates. Nisi[3] obtained similar results in the case of $NaNO_3$, KNO_3 and NH_4NO_3, working with single crystals of these substances. Raman spectra of aqueous solutions of nitrates studied by Grassmann,[4] Nisi[5] and others show that there is a splitting of one or both of the frequencies 720 and 1360 into two more or less diffuse components.

Placzek[6] has remarked that evidence from Raman and infra-red spectra suggests a plane structure for the $(NO_3)^-$ ion, with the symmetry D_{3h}. It will then have four distinct fundamental frequencies of which two are doubly degenerate. The selection rules show that the degenerate frequencies are allowed in the Raman effect as well as in the infra-red; the totally symmetric vibration is forbidden in the infra-red but can be expected to appear with great intensity in Raman effect; the perpendicular vibration is forbidden in the Raman effect but is allowed in the infra-red. Infra-red absorption spectrum of $NaNO_3$ studied by Schæfer and his co-workers[7] shows absorption maxima in the neighbourhood of 720, 830 and 1360 cm.$^{-1}$ The frequency 830 is not observed in the Raman effect, while the most intense Raman frequency near 1050 fails to appear in the infra-red. These facts suggest that 720 and 1360 represent the degenerate, 1050 the totally symmetric and 830 the perpendicular, frequencies of the $(NO_3)^-$ ion. The observed splitting of the degenerate frequencies in aqueous solutions of nitrates is then left unexplained.

Recently, I have taken up a systematic investigation of the Raman spectra of inorganic nitrates, and have obtained results which appear to be of significance in this connection. Employing the technique of complementary filters[8] I have photographed the Raman spectra of a large number of crystalline nitrates of mono-, bi- and tri-valent metals. Most of the salts studied by me were hydrated, and contained the appropriate number of molecules of water of crystallisation. Typical photographs of the spectra obtained in a few cases are reproduced in Fig. 1.

In almost all cases, the spectra reveal many new and interesting features which have been entirely overlooked by the previous investigators. Not the least important of these is the water-band in the 3μ region in the case of the hydrated salts, which shows amazing changes in intensity and structure from substance to substance. As regards the vibrational frequencies of the $(NO_3)^-$ ion, the most salient features are the following :—

(i) In the case of crystalline $NaNO_3$—this does not contain water of crystallisation—three vibrational frequencies are observed which correspond to those reported by previous investigators. *All these three are very sharp lines*, the one near 1060 being the most intense.

(ii) The spectra of the nitrates of bi- and tri-valent metals—all the substances examined so far are hydrated crystals—show that in all cases the frequencies near 720 and 1360 are split up into two or more components which are generally broad and diffuse in the case of the higher frequency. The most intense nitrate frequency near 1050 cm.$^{-1}$ also shows large structural changes from one nitrate to another. It is sharp in the case of $Mg(NO_3)_2 \cdot 6H_2O$, shows

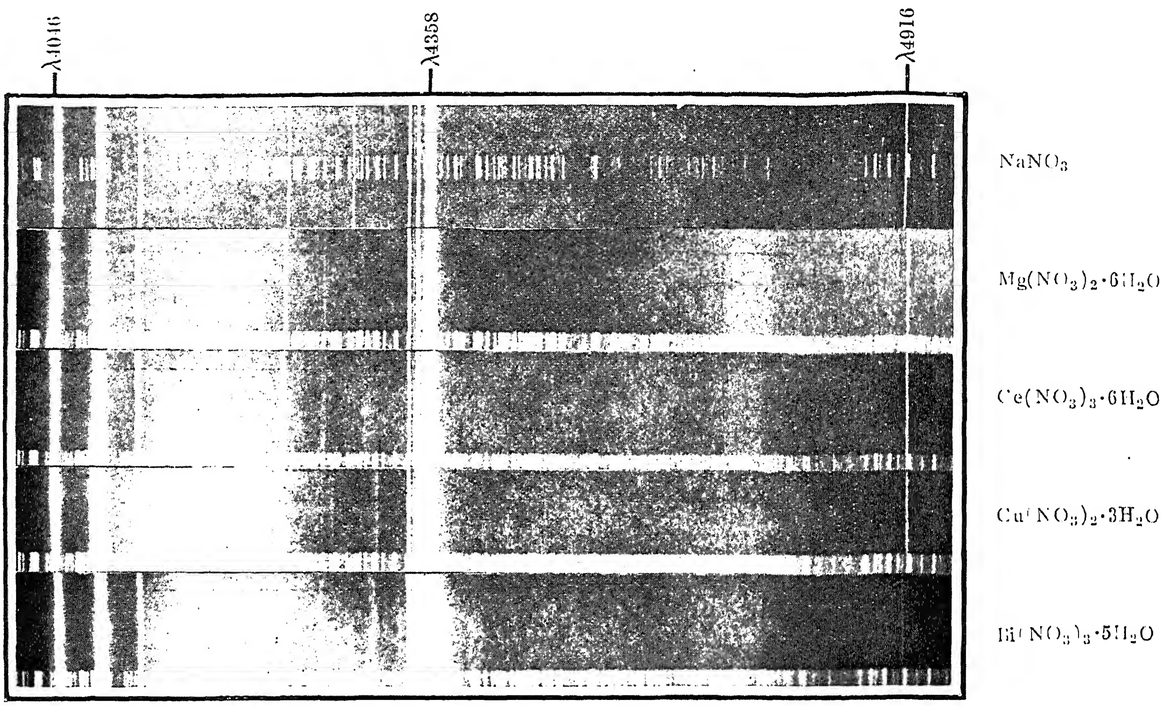

Fig. 1.

Raman spectra of crystalline nitrate.

a wing to its left in the spectrum of $Bi(NO_3)_3 \cdot 5H_2O$, is just split up into two components of equal intensity in the spectrum of $Ce(NO_3)_3 \cdot 6H_2O$, and appears as two well-separated components of unequal intensity in the Raman spectrum of $Cu(NO_3)_2 \cdot 3H_2O$. A surprising feature of the Raman spectrum of $Cu(NO_3)_2 \cdot 3H_2O$ is the appearance of as many as eight distinct frequencies in the spectral region between 700 and 1500 wave numbers.

The significance of these and other results obtained in this connection will be discussed in a paper which will appear shortly in the *Proceedings of the Indian Academy of Sciences*.

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Bangalore,
February 12, 1937.

[1] For the complete bibliography, see "Raman Effect" (J. Weiler), *Landolt Börnstein Physikalisch-Chemische Tabellen*, 1935, 938-40.

[2] P. Krishnamurti, *Ind. Jour. Phys.*, 1930, **5**, 1.

[3] H. Nisi, *Proc. Phys. Mat. Soc. Japan*, 1933, **15**, 114.

[4] P. Grassmann, *Z. f. Phys.*, 1932, **77**, 616.

[5] H. Nisi, *Loc. cit.*

[6] G. Placzek, *Handbuch der Radiologie*, 1934, **Teil II**, 309.

[7] C. Schæfer and C. Bormuth, *Z. f. Phys.*, 1930, **62**, 508.

[8] R. Ananthakrishnan, *Curr. Sci.*, 1936, **5**, 131; *Proc. Ind. Acad. Sci.*, (A), 1937, **5**, 76.

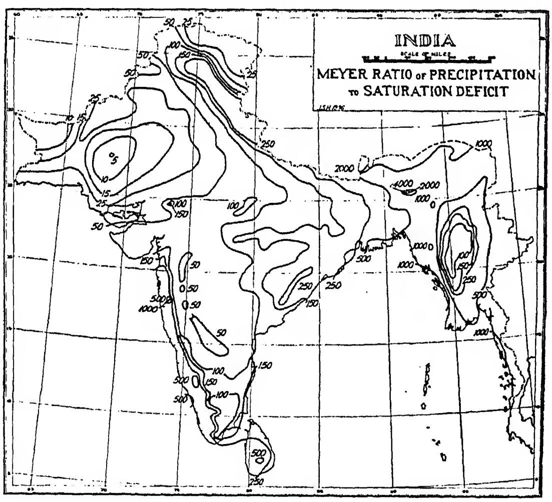
The Ratio of Precipitation to Saturation Deficiency of the Atmosphere in India.*

DURING the course of an investigation into the possible relationships between the black earths of Australia and the regur of India[1] (Hosking, 1935) certain climatic values were calculated for India in order that a comparison might be made of the general climatic factors controlling the occurrence of these soils.

Of the various single value climatic factors employed in the study of the connection between climate and soil distribution, Meyer[2] (1926) considered the simple ratio of precipitation (rainfall in inches) to the absolute saturation deficiency of the atmosphere (in inches of mercury) to be the

* From the Division of Soils, Council for Scientific and Industrial Research, Australia.

most efficient for this purpose and mapped the distribution of this ratio for Europe. In an attempt to correlate the soils of the United States of America with those of Europe, Jenny[3] (1929) covered that country in a similar manner. Following a critical examination of the various factors considered, Prescott[4] (1934) has substantiated the recommendation of Meyer and considers the Meyer ratio the most expressive in a preliminary study of the relationships between climatic conditions and the geographical distribution of plants, animals and soils and calculated the values for Australia. So far the distribution of this factor for India has not been attempted. Raman and Satakopan[5] (1935) have, however, characterised the climate of India by means of the single value factor "the annual rainfall *minus* the annual evaporation". They estimated the monthly and annual evaporation for 80 stations throughout India, saturation deficiency being the most important factor concerned in these estimations. The map presented in this paper extends Meyer's method to the study of Indian data.



The information for the purposes of calculating this data was drawn from the monthly reports of the Indian Weather Review up to the end of 1934 supplemented by various memoirs of the Indian Meteorological Department.

The mean annual temperature and water vapour pressures, calculated in the usual manner from the mean monthly values recorded, were the observations employed in calculating the saturation deficit. Maps showing their distribution were first constructed, interpolations for height above sea-level being necessary in certain areas, in which a good agreement was obtained in cases where data for "Hill stations" could be compared. From these a satisfactory distribution for saturation deficit was obtained. In the final preparation of the Meyer ratio map the calculated values for the given localities were entered and interpolations made by superimposing the rainfall map on that showing the saturation deficiency.

The extreme conditions of aridity in the region of the Thar Desert and Indus Valley and of humidity along the western coastal regions of India, Burma and Assam and throughout Bengal and Assam are emphasised. A minimum value of approximately 5 for the Meyer ratio is shown in the vicinity of Sukkur in the Sind Province, while Cherrapunji in the Khasi Hills of Assam records a maximum value of over 4,000.

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[1] Hosking, J. S., *Trans. Roy. Soc. S. Aust.*, 1935, **59**, 168.

[2] Meyer, A., *Chem. der Erde*, 1926, 209.

[3] Jenny, H., *Soil Research*, 1929, **1**, 139.

[4] Prescott, J. A., *Trans. Roy. Soc. S. Aust.*, 1934, **58**, 48.

[5] Raman, P. K., and Satakopan, V., *Sci. Notes, India Met. Dept.*, 1935, **6**, No. 61.

Crystal Structure of *p*-Azotoluene—Space Group.

The crystals of *p*-azotoluene belong to the monoclinic prismatic class and the axial ratio is

$$a : b : c = 2\cdot1768 : 1 : 1\cdot9674, \beta = 90°16'.^{1}$$

Rotation photographs taken about the a, b and c axes gave the following axial lengths:

$$a = 12\cdot0 \text{ Å}, \ b = 4\cdot85 \text{ Å}, \ c = 9\cdot703 \text{ Å}.$$

The axial ratio ($a : b : c :: 2\cdot474 : 1 : 2\cdot00$) calculated from the above dimensions for the unit cell gives for the interfacial angles values which are in very good agreement with those measured by Groth. The oscillation photographs taken about the three axes show that (hol) planes are halved when h is odd and (010) is also halved. The crystals therefore belong to the space

group C_{2h}^5. The calculated number of molecules in the unit cell is two. This indicates that the molecules possess a centre of symmetry.

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The Royal Institute of Science,
Bombay,
January 16, 1937.

[1] *Cf.* Groth, *Chem. Krystallg.*, 5, 66.

Isosterism and Constitution of Diazomethane and its Derivatives.

THE cyclic structures originally given by Curtius for diazomethane and its derivatives, were subsequently abandoned when Angeli, Thiele and Staudinger showed that these give rise to open chain compounds and hence should possess the open structures. Based upon the linear structure, Bradley and Robinson have explained all the reactions of the diazenes according to the electronic theory.[1]

During the past few years a good deal of physical measurements have been made with a view to decide between the alternative structures. The parachor has been shown to be incapable of decisive value. The dipole moment favours the ring structure though it can also be compatible with open chain resonance structures. Evidence from absorption spectra is variously interpreted. The method of electron interference seems to support the ring form. There is obviously great difficulty in employing the physical measurements satisfactorily owing to peculiarities connected with this group of compounds. Useful information can be obtained from analogy with the azides, which are more easy to work with. Cumulative evidence from thermo-chemical measurements, Raman spectra and X-ray crystal analysis indicate that the azides have a linear structure and the low value of dipole moments could be attributed to the existence of resonance.

Further support for the open structure is available from considerations of Isosterism. Langmuir[2] stated that azides are isosteric with isocyanates and diazomethane isosteric with ketene. The isosterism between azides and isocyanates has been examined by Pauly and Hendricks[3] who showed that they have very similar physical properties. No data have been collected till now, in regard to isosterism between ketene and diazomethane. Very few physical properties have been studied owing to the difficulties attendant on the examination of these highly reactive compounds. The available data are given below:

	Diazomethane.	Ketene.
Boiling Point	− 24° to − 23°C.	−56°C. (−41°C.)
Freezing Point	−145°C. −151°C	(−134·6°C.)

The values for the ketene given in the brackets are more recent and given by Rice, Greenberg and others.[4] Langmuir's suggestion that the two are isosteric seems to be supported by the above properties. The resemblance in chemical properties is well known. Compounds that are isosteric have similar structures. There is only one possible structure for the ketene, which is the open form; $\begin{matrix}H\\H\end{matrix}\!\!>C=C=O$; and hence diazomethane should be expected to have the open structure: $\begin{matrix}H\\H\end{matrix}\!\!>C=N\rightarrow N$.

I wish to thank Dr. T. R. Seshadri for advice.

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Department of Chemistry,
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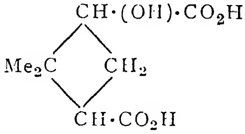
and Technology,
Waltair,
February 3, 1937.

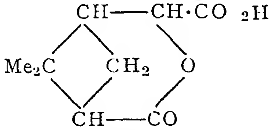
[1] Bradley and Robinson, *J.C.S.*, 1928, 1310.
[2] Langmuir, *J.A.C.S.*, 1919, 1544.
[3] Pauly and Hendricks, *J.A.C.S.*, 1926, 641.
[4] Greenberg and others, *J.A.C.S.*, 1934, 1764.

The Configuration of Pinic Acid.

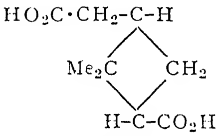
SINCE pinic acid, obtained from *cis*-pinonic acid by alkaline hypobromite, is degraded to *cis*-norpinic acid, Perkin and Simonsen[1] concluded that pinic and hydroxy-pinic acids possess *cis*-configuration. The fact that hydroxy-pinic acid (I) in spite of its being a δ-hydroxy acid does not form a lactone (II)[1,2] led us to suspect that this acid as also pinic acid from which it is derived might possess *trans*-configuration. The elucidation of the configuration of pinic acid was taken up first by (i) independent synthesis which is in progress and (ii) by a comparison of the properties of pinic acid (III) obtained by oxidising the glycol (IV) which has been proved by us[3] to be of the *trans*-configuration.



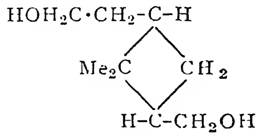
(I)



(II)



(III), (III*a*)



(IV)

Recently, the abstract of a paper by Grandperrin[4] came to our notice wherein he has suggested, though with some negative experimental evidences only, the pinic acid (III*a*) obtained by the alkaline oxidation of *cis*-pinonic acid to be of the *trans*-form. In view of this publication we hasten to present the experimental evidences so far obtained by us, which definitely confirm that pinic acid is of the *trans*-form.

Pinic acid (III*a*) (b.p. 206–207°/6 mm.) has now been prepared directly from *cis*-pinonic acid and its diethyl ester reduced by sodium and alcohol to the glycol (IV) which on oxidation with permanganate gave pinic acid (III) (b.p. 204–05°/5 mm). This acid, by analogy with our previous work[3] should possess the *trans*-configuration. The identity of the two acids (III*a*) and (III) (*cf.* B.P. identical) has been further established by the fact that both of them give the same dianilide (m.p.'s and mixed m.p. 204°) and diamide (m.p.'s and mixed m.p. 222–23°).

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V. K. Subramanian.

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Bangalore,
January 22, 1937.

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[1] *J.C.S.*, 1909, **95**, 1176.

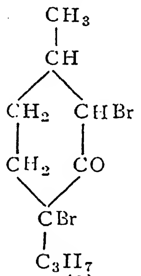
[2] Bayer, *Ber.*, 1896, **29**, 1908.

[3] Guha and Ganapathi, *Curr. Sci.*, 1936, **5**, 244.

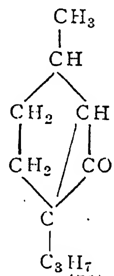
[4] *Am. Chem. Abst.*, Nov. 20, 1936, **30**, 8191; *Annalen der Chemie*, 1936, **6**, 5–53.

Synthesis of Thujane.

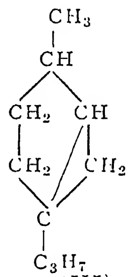
Thujane, the parent hydrocarbon of the naturally occurring bicyclic terpenes of this group, appears to have been synthesised starting from menthol as follows: menthol is oxidised to menthone (b.p. 98–100°/18 mm.; semicarbazone m.p. 185°, the lowest m.p. recorded in literature being 185°), which gives a dibromo-derivative, *viz.*, 2 : 6-dibromo-3-methyl-6-isopropyl-cyclohexane-1-one[1] (I). This dibromo-derivative on treatment with zinc dust in alcoholic solution has yielded the bicyclo-(0 : 1 : 3)-hexane derivative (II), b.p. 205–07° at ordinary pressure and 110–112°/14 mm.; $n_D^{23°}$ 1·4505. It gives two isomeric semicarbazones, one melting at 175–76° and the other melting at 150–51°. The bicyclic ketone (II) on reduction by Clemmensen's method, *viz.*, by zinc amalgam and hydrochloric acid has yielded thujane (III), b.p. 156–57°; $d_4^{22°}$ 0·8140; $n_D^{20°}$ 1·4410; the corresponding values of Thujane as given by Semmler and Feldstein[2] being b.p. 156–57°; $d_{21°}^{22°}$ 0·8158; n_D 1·44121. The identity of the synthetic variety of thujane has also been established by comparing its properties with those of thujane prepared by direct reduction of thujone by Clemmensen's method.



(I)



(II)



(III)

The synthesis of thujane by Ruzicka and Koolhaas[3] from α-thuja-ketonic acid (a direct degradation product of thujone) being only a partial synthesis, the present synthesis constitutes the first total synthesis of a bicyclic compound of this group of terpenes, subject to further confirmation.

Our thanks are due to Mr. S. Krishna Moorthy for rendering some help in the preparation of the starting materials.

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[1] Beckmann, Eickelberg, *B.*, **29**, 418.

[2] *Ber.*, 1914, **47**, 387.

[3] *Helv. Chim. Acta.*, 1932, **15**, 944.

Constitution of Butrin Isolated from *Butea Frondosa* Flowers.

THE crystalline glucoside butrin, $C_{27}H_{32}O_{15}2H_2O$ isolated from the flowers of *Butea Frondosa*, has been shown to be a glucoside of butin, which is 3 : 4 : 7 trihydroxy flavanone. It is obtained from hot alcohol as dihydrate (most stable) tiny silky needles, $[\alpha]_D^{31°·5} = -73°·27$ in water (C, 0·396) and as pentahydrate (silky needles) from hot water: the pentahydrate loses $3H_2O$ on keeping over H_2SO_4 or $CaCl_2$ for ten days at ordinary temperature. Anhydrous (I) $[\alpha]_D^{30°} = -81·7$ in pyridine (C, 1·681) obtained by heating dihydrate or pentahydrate at 120° is hygroscopic and readily takes up $2H_2O$ from air.

On hydrolysis with dilute mineral acids (I) gives 2 molecules of glucose and one molecule of butin, $C_{15}H_{12}O_5$ which is 3′ : 4′ : 7 trihydroxy flavanone. It contains nine hydroxy groups but yields by the action of acetic anhydride and anhydrous sodium acetate at 130–135°, a deca-acetyl derivative $C_{27}H_{22}O_5(O.CoMe)_{10}.H_2O$, on account of the rupture of the pyrone ring with simultaneous acetylation of the newly formed phenolic hydroxy group of the chalkone, as pale flakes from methyl alcohol, m.p. 119–120°, $[\alpha]_D^{30°}$ of anhydrous derivative is $-79°·86$ in pyridine (C, 1·2242); by Deninger's method a nonabenzoyl derivative $C_{27}H_{23}O_6(O.Co.C_6H_5)_9$, H_2O, m.p. 141° colourless nodules from hot alcohol, $[\alpha]_D^{30°}$ of anhydrous derivative = 77°·20 in pyridine (C, 2·5250); by the action of *p*-nitrobenzoyl chloride and pyridine, a tetra *p*-nitrobenzoyl derivative, $C_{27}H_{28}O_{11}$ $(O.Co\ C_6H_4.No_2)_4$, m.p. 154° $[\alpha]_D^{30°} = -44°·30$ in pyridine (C, 2·8912); by the action of hydroxylamine hydrochloride and anhydrous sodium acetate in ethyl alcohol a mono-oxime $C_{27}H_{32}O_{14}.NOH$, $2H_2O$, flakes from hot alcohol, m.p. 180° after shrinking at 165°; with ethyl chlorocarbonate, and pyridine a carbethoxy derivative, m.p. 83–84° after shrinking at 82°.

Acetyl-, benzoyl-, *p*-nitrbenzoyl-, and carbethoxy derivative do not dissolve in cold concentrated alkali, give no colouration either with Mg and methyl alcoholic hydrochloric acid nor with hot or cold concentrated hydrochlroic acid but give with cold concentrated H_2SO_4 orange red, orange, yellow on heating only, bright yellow colouration which changes to orange red on warming, respectively. The oxime gives with concentrated hydrochloric acid a deep yellow colouration changing to orange on heating and orange red with cold concentrated sulphuric acid; and dissolves in alkali to yellow solution.

(1) In hot aqueous solution by the action of lead acetate and subsequent dilution of its cold alcoholic solution with water yields a bright yellow crystalline salt $C_{27}H_{30}O_{13}$ $(O.PbO.COMe)_2$, $2H_2O$, m.p. 128° after shrinking at 115°; $(CH_3)S.O_4$ and KOH yield methyl butrin, m.p. 82–84°, deep yellow powder; with C_2H_5I, K_2CO_3 (anhydrous) in ethyl alcohol diethyl butrin, $C_{27}H_{30}O_{13}(OEt)_2$ $\frac{1}{2}H_2O$ a white crystalline stuff, m.p. 238°. It contains the flavanone nucleus and with Mg and methyl alcoholic hydrochloric acid gives reddish violet colouration, pinkish red with concentrated sulphuric acid and none even with hot concentrated hydrochloric acid and from the mother liquor is obtained the isomeric chalkone as bright yellow nodules, m.p. 183° (uncorr.), $C_{27}H_{30}O_{13}(OEt)_2$, $4\frac{1}{2}H_2O$ which loses $3\frac{1}{2}H_2O$ at 120° and gives a yellow colouration with hot concentrated hydrochloric acid. By taking methyl iodide in place of C_2H_5I and crystallizing from boiling water, are obtained tiny needles of *o*-methyl butrin $C_{27}H_{30}O_{30}(OCH_3)_2$, $7\frac{1}{2}\ H_2O$, m.p. 224° (uncorr.) which loses $7H_2O$ at 140°. (I) with H_2O_2 and KOH (16%) 0–5° for 24 hours and subsequent hydrolysis yields Fisetin but the intermediary flavanol glucoside could not be crystallized.

It is concluded that butrin is a bioside and not a di-glucoside but the position of biose residue is still undetermined.

The author wishes to express his indebtedness to Dr. S. Dutt, D.Sc., P.R.S., for his kind interest in the work.

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Allahabad,
October 7, 1936.

Interference of Soil in the Estimation of Furfural.

IN the estimation of furfuraldehyde yield of soil organic matter, manures and of plant materials admixed with soil, it was found that the yield, as determined both by the phloroglucinol method as well as the volumetric bromine method, was seriously lowered by the presence of soil. The percentage recovery of furfural from added plant materials of known composition varied with the nature of the soil and decreased

with an increasing ratio of soil to plant material; at a ratio corresponding to 4 per cent. of organic matter in the soil, the recovery was, in some cases, as low as 50 per cent. A comparison of the behaviour of the soil before and after ignition showed that the interfering effect was not due to the organic constituents of the soil, *e.g.*, lignin, but was due mainly to the inorganic components. In fact, organic fractions such as lignin and tannin, reported by other workers as interfering in the estimation of furfural[1] were found to exert only a slight harmful effect in comparison with the soil inorganic fraction.

A detailed examination of the nature of the interference, by adding known inorganic compounds to plant materials, prior to distillation with 12 per cent. HCl, showed that oxidising agents, such as ferric and manganic compounds, gave low recoveries of furfural. Ferrous and manganous salts were harmless. It was noteworthy that the effect of ferric and manganic compounds on added furfural was much less than that on added plant materials.

A method has been worked out for the correct estimation of the furfural content of organic residues in presence of soil, by a preliminary reduction of ferric and other oxidising compounds present, by the addition of the necessary amount of stannous chloride, and subsequent distillation with 12 per cent. HCl. Full details of the method will be published elsewhere.

C. N. Acharya.
Department of Biochemistry,
Indian Institute of Science,
Bangalore,
February 2, 1937.

[1] *Ind. Eng. Chem.* (Anal. Edn.), 1934, **6**, 205–08.

Staminodes in *Elatteria cardamomum* Maton.

In the description of *Elatteria cardamomum* Maton., given in "The Flora of British India" by J. D. Hooker, "Die Naturlischen Pflanzenfamilien" by Engler and Prantl, and in "The Flora of the Presidency of Bombay" by Theodore Cooke, no mention has been made of two staminodes that are found at the base of the corolla tube just at the top of the ovary (Fig. A–2). Including these two staminodes there are six members in the andrœcium: one petaloid staminode—the lip—"Longer than the corolla segments, white sheathed with violet" (Hooker); "two lateral staminodes minute teeth"; one functioning stamen

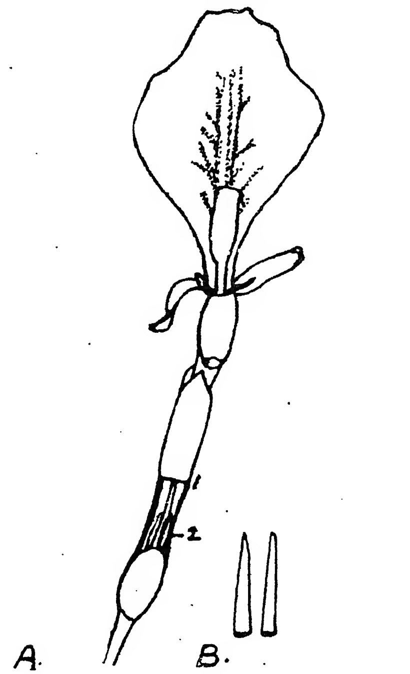

Fig. 1.

(A) Flower of *Elatteria cardamomum* Maton., with the calyx and corolla tubes cut open at the lower half—1, to show the two staminodes—2, at the base of the corolla tube. (B) The two staminodes at the base of the corolla tube enlarged.

with a short filament and contiguous anther cells; and two staminodes at the base of the corolla tube just at the top of the ovary (Fig. A–2). The two staminodes at the base of the corolla tube have been found also in *Elatteria cardamomum* var. Major Smith.

R. L. Narasimha Swamy.
Government Coffee
Experiment Station,
Balehonnur,
November 11, 1936.

A Note on the Development of the Embryo-sac in *Trichosanthes dioica* Roxb.

Trichosanthes dioica is a Cucurbitaceous plant which is commonly grown in Bengal as a vegetable crop for its fruits.

Previous work on the embryology of other Cucurbitaceous plants by Kirkwood[1] and Kratzer[2] has revealed that the development of the embryo-sac in this family is of the normal angiospermous type.

In *Trichosanthes dioica* the nucellus is at first composed of homogeneous cells. Very soon, however, a group of archesporial cells is noted below the epidermis. A single megaspore-mother cell differentiates out from this group of archesporial cells. It always differentiates in the third layer of the nucellar tissue. Due to the rapid division of the wall cells the megaspore-mother cell is pushed considerably inside the nucellus. It next increases in size and becomes elongated. After the completion of the heterotypic division a cell plate divides the cell into two equal halves. The homotypic division very soon follows and a normal linear tetrad of megaspores is produced in every case. The chalazal megaspore functions and by three successive divisions it develops into an 8-nucleate embryo-sac. The mature embryo-sac is of the normal angiospermous type.

The integuments which are two in number, do not come very close in the mature ovule and as a result the micropylar opening is rather wide. The outer integument is massive and consists of several layers of cells, while the inner integument as a rule consists of two layers of cells only.

I. BANERJI.
M. C. DAS.

Department of Botany,
Calcutta University,
January 13, 1937.

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[1] Kirkwood, J. E., *Bull. N. Y. Bot. Gard.*, 1905, **3**, 313-402.
[2] Kratzer, J., *Flora*, 1918, **110**, 275-343.

Nuptial Relation of *Diacamma vagans*, Smith.

THE females of the genus *Diacamma* are unknown[1] and so far no one seems to have mentioned it as having discovered. Wheeler (1910) is of opinion that the female function of *Diacamma* has probably been usurped by the gynæcoid workers as in certain Ponerine ants.[2] For some time I myself have been in search of females of *Diacamma vagans* and wherever I have come across formicaries I have excavated them but all in vain. In most of these colonies two or three males along with a number of workers only are found. The latter possess receptaculum seminis and ovarian tubules which led me to investigate if the queen phase of *D. vagans* has actually been supplanted by gynæcoid workers,[3] as also to see what rôle has the male to play in the life-history of the species. For this purpose I reared the workers in different artificial formicaries having diet regulating arrangement. One of these formicaries, the inmates of which were poorly fed, was soon found to be the haunting ground of a male of the species which flew to it from outside. The male was welcome. It was being caressed and carried hither and thither by the workers of the colony. After some time the male was observed in the act of mating with a worker, the posterior half of the former's abdomen having been inserted into that of the latter. The male by bending its abdomen was resting upon the back of the worker making itself erect at intervals. I caught hold of them in that position and to prevent the male from detaching itself from its mate I chloroformed the latter to bring about a sudden contraction of its sexual organ. The male also was then killed, and the specimens have been preserved carefully in that state. Their photographs *in situ* are reproduced here.

Mating of *D. vagans* × 2.
Left—Male. *Right*—Female.

Such a case of actual mating has, to my knowledge, not been reported before.[4] If gynæcoid "is a physiological rather than a morphological phase"[5] it evidently does not admit of the sexual act.

G. BHATTACHARYA.

Bose Institute,
Calcutta,
January 25, 1937.

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[1] Bingham, C., "Formicidæ," *Faun. Brit. Ind.*, (Hymn), 1903, **2**, 76.
[2] Wheeler, W., *Ants. N. Y.*, 1910, 243; *Ibid.*, pp. 97, 113, 243, 266, 527.
[3] Wasmann, E., *Mitth. Schweiz. Ent. Gesell.*, 2, 1904, 67–70.
[4] Wheeler, W., p. 40.
[5] Imms, A., *Text-book of Entomology*, Lond., 1934, 588; Wheeler, p. 97.

A Case of Polyembryony in the Nyctaginaceæ.

An example of polyembryony has been observed in *Bœrhaavia repanda* Willd. A photograph of the preparation showing this condition is reproduced below. The accessory embryo is seen to develop from a synergid.

There are two conditions which seem to be responsible for this kind of development, the occurrence of egg-like synergids and the penetration of accessory pollen-tubes into an embryo-sac. During the course of the investigations going on in this department on the embryology of the flowering plants, both of these conditions have been noted quite frequently in several families of the Centrospermales. It could, therefore, be anticipated that in some cases the simultaneous presence of these characters would lead to the development of polyembryony.

In the Nyctaginaceæ, the presence of accessory pollen-tubes has been recorded both in *Bœrhaavia diffusa*[1] and *B. repanda*.[2] Two pollen-tubes were also seen penetrating the ovule showing polyembryony and figured here. The presence of egg-like synergids has been seen in *B. diffusa*.[3] In *B. repanda*, the material of pre-fertilisation has not been examined, but as the two species are very similar in all their embryological features, egg-like synergids are likely to occur in this species as well. The vacuolation of the basal cells of both the embryos from the polyembryonous ovule is seen to be egg-like. It can, therefore, be concluded that the polyembryony in *B. repanda* has most probably developed from the fertilisation of an egg-like synergid by a male gamete from an accessory pollen-tube in addition to normal fertilisation.

In the family Nyctaginaceæ, no other instance of polyembryony has been recorded so far.

The writer takes this opportunity to thank Prof. A. C. Joshi for his help in the preparation of this note.

L. B. Kajale.

Department of Botany,
Benares Hindu University,
January 25, 1937.

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[1] Observed by Maheshwari, *Jour. Ind. Bot. Soc.*, 1929, and the writer.
[2] Observed by the writer.
[3] Observed by the writer.

On a Cymothoan Parasitic on Some Brackish-Water Fishes from Madras.

Several species of Cymothoa (Order Isopoda) are known to inhabit the mouth and gill chambers of fishes, but most of the known species are marine. The well-known fresh-water representatives are *Cymothoa amurensis* Gerst. parasitic on *Cyprinus lacustris* from the river Amur, in Eastern Asia, and *C. henseli* on *Geophagus* sp. from Rio Cadia in Brazil.[1] *Cymothoa indica* Schiödte and Meinert,[2] first described from Bangkok, Siam, has been recorded by Chilton[3] from the Chilka Lake, where it is stated to be "not uncommon in the mouth of the large goby *Glossogobius giuris*, where the parasite causes a deformation of the tongue". A species of parasitic Isopod was frequently noticed by us in certain species of fishes collected from the Adyar backwaters during the last three years.

The parasites belong to the genus *Cymothoa* Fabr. characterised by the presence of the large abdominal shield, antennæ widely separate at their origin, and other important features. The large ovigerous females agree with the description and figures of *C. indica* given by Nierstrasz in his account of the Isopods of the Siboga collections.[4] The largest specimens (ovigerous females) obtained by us measure 19 mm. long and 9 mm. wide at the broadest part, while the smallest individual is 3 mm. long and 1 mm. wide. The body is long and oval in the large females. As

in other species of *Cymothoa*, the abdominal region is sharply contracted as compared to the rest of the body. The eyes are situated on the sides of the anterior margin of the head; they are large and distinct in the young specimens but become progressively indistinct with increase in size, and in the very large individuals with brood pouches, the eyes are scarcely distinguishable. The same observation is made by Chilton for specimens from Chilka Lake. Judged from the structure of the eyes of young individuals, they definitely appear to be functional during early life, but, as suggested by Eggert,[5] undergo degeneration with increase in age as a result of the peculiar habit of the adult. At Adyar, the parasites have been taken from the mouth and gill chambers of two Chiclid Fish *Etroplus maculatus* and *E. suratensis*, and the goby *Glossogobius giuris*. The number of fish examined, and of those infected are given in the following table :—

Host species	No. of specimens examined	No. of specimens with parasites
Etroplus maculatus ..	54	42
Etroplus suratensis ..	12	6
Glossogobius giuris ..	6	3

It would be seen from the table that the percentage of infection is much higher in *Etroplus maculatus* than in that of the other two species. Though several other species of fish collected from the Adyar have been examined by us, this parasite has been so far observed only in the three species noted above. In each fish, two parasites are normally found, of which one is the large Ovigerous female found in the mouth, and the other, the smaller and more active male usually observed on the gills. Females with embryos have been collected during different months of the years; the number of embryos in the brood pouch normally varies from 30 to 90.

The species of *Cymothoa* commonly met with in India are all from marine fishes. *Etroplus maculatus* and *E. suratensis* are commonly found in fresh- and brackish-water, but are not known to enter the sea. *Glossogobius giuris* is found in sea, brackish- and fresh-water. We have found the Cymothoans on the above fishes collected from the Adyar backwaters where the salinity is fairly high (18 to 30 per mille) as well as from about four miles up the river where the water is practically fresh.

N. KESAVA PANIKKAR.
R. GOPALA AIYAR.

University Zoological Laboratory,
Madras,
January 23, 1937.

[1] Gerstacker, A., and Ortmann, A. E., "Die Klassen und Ordnungen der Arthropoden," in Bronn's *Klassen und Ordnungen des Their-Reichs*, 1901, **Bd 5**, Abt. II. *Crustacea*, Hft. Malacostraca, Leipzig.

[2] Schiödte, J. C., and Meinert, Fr., *Naturhist. Tidsskr.*, 1884, **4**, Ser. 3, p. 221, Kopenhagen.

[3] Chilton, Chas., *Mem. Ind. Mus.*, Calcutta, 1924, **5**, 875.

[4] Nierstrasz, H. F., *Siboga Expeditie*, 1931, XXXII c, p. **123**, Leiden.

[5] Eggert, Bruno, *Zool. Anz.*, 1927, **Bd. 73**, (1/2), 33, Leipzig.

A New Easy and Inexpensive Method for Taking Photomicrographs.

FROM year to year the markets are flooded with the most modern apparatus for photomicrography and those laboratories which possess the old apparatus and have no funds to purchase the latest novelty are supposed to be handicapped. The trade depression of firms like E. Leitz, Wetzlar & Zeiss, Jena, stimulates the production of new apparatus. Many instruments with but slight changes and most fascinating advertisements are introduced every year into the markets and one requires a huge fortune to renew the old apparatus of a laboratory. Many different kinds of appliances have been invented for photomicrography recently, but, every one cannot handle these with success without a thorough training and experience.

A very simple and inexpensive method for taking photomicrographs is described in this paper. All that is required is (1) a Leitz Monla lamp with regulating transformer, (2) a Microscope and (3) an Abbe's prism. The Leitz Monla lamp may be replaced by an electric table-lamp with 100 Watt bulb and a long opaque shade. A Leitz Monla lamp is preferred because it may be overloaded up to 6 amperes without risk of blowing, and lights up immediately the current is switched on. On account of the concentrated form of the

radiant surface, as well as the overload which the filaments will bear, this lamp furnishes the highest lighting effect which is attainable with any filament lamp. The lamp bulb is enclosed in a casing furnished with a slit for the reception of a ground-glass screen. The lamp lens, which is specially designed for use with filament lamps, has a helical focussing motion.

The arrangement is depicted in Fig. 1, installed in a dark-room with a ruby lamp over it. The image of the object desired to be photographed is focussed on a white sheet of paper. The lamp is switched off and the paper is replaced by a printing-paper. In order to cut off the extra light, the lamp

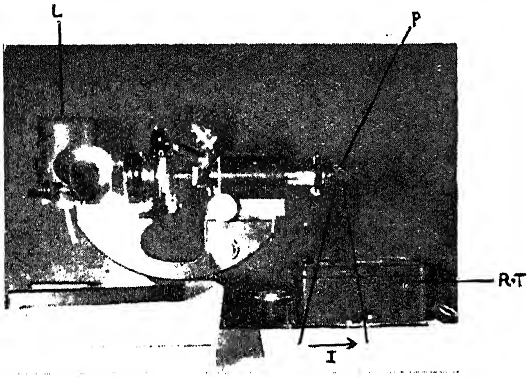

Fig. 1.

L. Leitz Mola Lamp. R.T. Regulating Transformer.
P. Abbé's Prism I Image of the object.

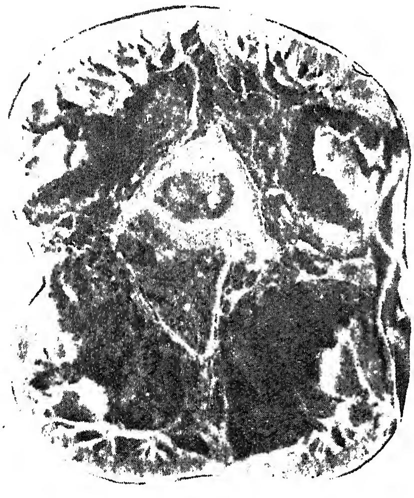

Fig. 2.

Direct impression of the object on the printing-paper (A negative picture).

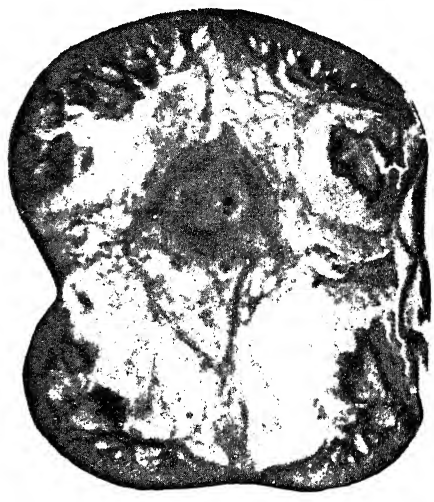

Fig. 3.

A positive print of the same object as in Fig. 2.

and microscope are covered by means of a thick black cloth. It is recommended that Agfa Brovira Hard papers be used. With the full intensity of the Monla lamp, only a second's exposure is enough to get the impression. Fig. 2 represents the photomicrograph taken by a direct exposure on the printing-paper, while Fig. 3, is a positive picture of the same object taken by Leitz Leica Camera. A direct impression is recommended for histological preparations, specially for showing the nervous structures. It is only a convention that the nucleus be shown as a darkly stained body and this convention can be set aside in favour of saving time, labour and expenses.

If the negative prints are not desired then the impression could be taken on a process plate of a slow speed and the intensity of light can easily be controlled in order to give the right exposure. This eliminates the expenses of purchasing a camera for photomicrography.

In taking a direct impression on printing-paper, the cost would be about one anna and three pies per quarter size picture and plenty of time and labour is saved thereby. On the contrary, positive prints would cost not only time and labour but also five annas and three pies per picture if taken according to the method described above.

M. A. Basir.

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Aligarh, U. P.

REVIEWS.

Magnetochemie. By Dr. Wilhelm Klemm. (Akademische Verlagsgesellschaft M. B. H., Leipzig), 1936. Pp. 262. Price 16 R.M.

The importance of magnetic measurements in dealing with chemical problems can be gauged from the fact that within a year of the appearance of the first book in English on the subject of Magnetochemistry by S. S. Bhatnagar and K. N. Mathur (Macmillan & Co.), Dr. Wilhelm Klemm, Professor of the Techn. Hochschule Danzig-Langfuhr, has brought out a German monograph entitled *Magnetochemie.* The book covers a wide and varied field. The earlier chapters are devoted to general physical principles and methods of measurements. The treatment is satisfactory, and nearly everything of importance has been dealt with. The author has made a slip in ignoring altogether the large electro-magnet of Cotton and, while describing the methods of measurements, such important contributions as those of Bauer and Piccard, Wilson, Oxley, Bitter and several others may have been taken into consideration. There is a very good discussion of older theoretical results. A very reasoned criticism of the Langevin and Weiss theories leads on to the more modern concepts of magnetism based on the old and new quantum mechanics. Of particular interest are the accounts of the influence of temperature and the chemical linkage on the permanent moments, and the chapters on the magnetic properties of atoms and ions which deal fully with the theoretical methods of Kirkwood, Pauling, Hartree, Stoner, Slater, Angus and others.

Part III deals particularly with the application of magnetic properties to chemical problems, such as the determination of constitution as suggested by Pascal from susceptibility considerations and by Perkin and others from mangeto-optical and molecular refraction measurements.

Diamagnetism and polymerisation, free radical paramagnetism, compounds of rare earths, complexes both normal and penetration, rules of Sidgwick and Bose, the theories of Pauling and Van Vleck, the influence of crystal sturcture on magnetic properties, magnetism of elements and solid solutions have been treated in a systematic though reasonably brief manner. A particular feature of the book is the space devoted to the discussion of the intermetallic phases from the magnetic concept and the alloys so important in industry find special mention. The author is fully alive to the importance of magnetic measurements for analytical purposes and for other uses such as the separation of substances and in chemical kinetics. The book is a very useful addition to the literature on the subject of Magnetism and Chemistry and will no doubt attract the attention of research-workers in this field.

S. S. B.

Tables Annuelles de Constantes et Données Numériques de Chemie, Physique, Biologie et Technologie.—[Guthier-Villars (Paris); McGraw-Hill Book Co., Inc. (New York).] (1) *Numerical Data on Radioactivity, Nuclear Physics, Transmutations, Neutrons and Positrons*: (1931 to April 1936). By I. Juliot-Curie, B. Grinberg and R. J. Walen. Pp. 57. Price 8*s*.

Workers in the field of Nuclear Physics will gladly welcome the appearance of this section of the Annual Tables which is literally a treasure-house of information invaluable alike to the experimenter as well as to the theorist, on a branch of Physics which has had a phenomenal growth and has assumed considerable proportions during the last five years. As we are all aware, the rapid succession of discoveries in the field of Radioactivity and Nuclear Disintegration which this period has witnessed has led and is leading to results of far-reaching and fundamental significance relating to basic problems such as the Structure of the Atomic Nucleus, the Nature of Radiant Energy, the inter-relation between Energy and Mass and the validity of the hitherto-undisputed Conservation Laws of Nature. The brilliant part played by the Curies in the unfolding of this new knowledge can hardly be overstressed. The literature on the subjects embraced by the fascicle under review has grown with such rapidity and is scattered

over so many journals that we cannot be adequately thankful to the publishers in general and to the authors in particular for making it all so readily accessible to a wide circle of interested workers through the medium of the present publication.

The subject-matter is divided into two main sections. Section A deals with Natural Radioactivity under eight appropriate headings. Starting from the half-value periods of the naturally occurring radioactive elements the tables give exhaustive data concerning the spectra, energies, ionisation, range, slowing-down, and scattering by nuclei of α-rays. This is followed by the spectra and energies of β-rays and the spectra and absorption of γ-rays respectively. An account of the distribution of energy between the radiations emitted by radioactive elements, the chemical effects of these radiations and a list of the radioactive minerals and springs found in different parts of the world bring Section A to a close. Section B which occupies the greater part of the space gives first of all a systematic, complete and critical account of the numerical data relative to Transmutations and Induced Radioactivity. In presenting these data, the authors have classified the 92 known elements into two groups. As they have pointed out, the first thirty elements have been studied in great detail and a great many transmutations have been observed in these cases. Transmutations in the case of the remaining elements have been definitely established only when they are bombarded by neutrons, and in all these cases the resulting elements are found to be radioactive. The bibliography on transmutations shows at once the importance of the subject as well as the interest which it has evoked when one glances over the rapidly increasing number of publications year after year. Interesting and valuable data relating to Protons, Isotopes, Neutrons and Positrons are contained in the last few pages. We have little doubt that the fine get-up, clarity and completeness of the compilation combined with the low price of the fascicle will ensure for it a considerable demand.

(2) *Numerical Data on the Raman Effect: Spectra, Intensities and Vibration Patterns*: (1931 to 1934). By Dr. M. Magat. Pp. 112. Price 12*s*.

The importance of the information furnished by the study of the Raman Effect to workers in the field of Molecular Spectra and allied fields of physical and physico-chemical research needs no special emphasis. Dr. Magat has therefore fulfilled a task of great service to physicists and chemists at large by his careful and painstaking compilation and classification of the vast expanse of numerical data collected on the Raman Effect between the years 1931 and 1934. The substances are grouped according to their chemical constitution, the inorganic compounds being treated first, and the more numerous organic compounds in the second part. As Dr. Magat has emphasised, some difficulty is experienced in assessing the relative intensities of the Raman lines in a tabulation such as the one under review, since the visual intensity estimates generally given by investigators are only of an empirical and qualitative nature based on arbitrary standards.

The appendix at the end of the book which gives the vibrational modes, degeneracy, selection rules and polarisation characters of the Raman lines of typical molecules possessing certain symmetry elements adds greatly to its usefulness. Certain minor errors in this section which require correction might be pointed out. In Fig. 5, p. 103, which gives the normal modes of vibration of the AB_2 molecule, the diagrammatic representation of ν_σ is incorrect. For infinitesimal vibrations, the conservation of angular momentum demands that the motion of the B atoms should be along the sides of the triangle instead of being inclined to them as represented in the figure. In Fig. 15, p. 105 which represents the normal vibrations of the tetrahedral AB_4 model, the doubly degenerate mode ν_4 is incorrectly represented since the central atom is at rest in this vibration. It need scarcely be added that as a source of quick and ready reference the book will be of great help to workers engaged in the elucidation of molecular structure and constitution of chemical compounds.

A word of explanation is perhaps necessary for a publication such as the present one which deals only with the results obtained till the end of 1934 on a subject which is drawing forth an endless stream of research papers from day to day. We understand that it is part of the programme laid out by the Managing Committee to bring out in this and similar other cases supplementary

fascicles embodying the data obtained during the period 1935–1936. The fulfilment of this programme in 1937 will be awaited with great interest.

(3) *Numerical Data on Rotatory Power*: (1931 to 1934). By E. Darmois, Pp. 68. Price 8*s*.

This is essentially a well-arranged tabulation of the experimental results that have accumulated on the subject of Optical Rotatory Power between the years 1931 to 1934. The specific rotatory power of various groups of substances in the homogeneous state and in solution and the influence of temperature, concentration and solvent on the rotatory power are considered first. Exhaustive data relative to Rotatory Dispersion, Resolution of Racemic Compounds and Mutarotation which follow next occupy some forty pages. A short section on the influence of various additions on the optical rotatory power, and a final one which gives references to select original papers that are more or less of a theoretical nature on topics such as the Walden Inversion, Configuration Studies, Absorption and Rotatory Power, Optical Superposition and Asymmetric Synthesis are also added. The detailed bibliography at the end gives references to some 400 original papers that have appeared on the subject in the period covered by the tables.

R. ANANTHAKRISHNAN.

The Aromatic Diazo Compounds and Their Technical Applications. By K. H. Saunders. (Edward Arnold & Co., London), 1936. Pp. xii + 224. Price 12*s*. 6*d*.

The peculiar properties of the diazo compounds render them very valuable both to the manufacturer of dyestuffs and chemicals on a large scale and the chemist engaged in research. Since the publication of the second edition of Cain's book *Chemistry and Technology of the Diazo Compounds* appeared about two decades ago, and since in the interval, great advances in the chemistry and technical applications of this group of compounds have taken place, the present book supplies a definite need. It gives a clear and concise account of the subject up to date and in spite of its larger scope the size has not been unduly increased. Appropriate to the title, the consideration of the aliphatic diazo compounds has been omitted. By judiciously limiting the space allotted for the discussions of theories, the author has given due prominence to the descriptions of the reactions. The theoretical portion, instead of being an indiscriminate compilation of all and sundry ideas, gives a critical and well-thought-out review of the important developments. The book will be a very useful addition to any scientific and technical library.

T. R. SESHADRI.

Kurzgefasstes Lehrbuch der Physiologischen Chemie. By S. Edlbacher. (Walter de Gruyter & Co., Berlin and Leipzig), 1936. 3rd Edition. Pages 286. R.M. 8·50.

The book is essentially for students going in for a degree course in medicine and as such it fulfils the purpose admirably. The arrangement of the subject-matter follows the usual sequence found in the books on the subject. The book is indeed remarkable for the lucidity of expression. The author has succeeded in presenting some difficult aspects of the subject, *e.g.*, the stereochemistry of amino-acids, the chemistry of proteins, etc., in a manner so as to be comprehensible even to a student possessing something less than an average intelligence. The subject-matter has been brought up-to-date which in itself is no mean achievement for a "Kurzgefasstes Lehrbuch". Some printers' errors, however, have been overlooked, *e.g.*, an O-atom has been left out in the formula of β-glucoside (p. 14), "Carboxyl" for Carbonyl and "Joung" for Young are in the text, which will, I hope, be rectified in the next edition.

V. N. PATWARDHAN.

Manual of Pharmacology. By W. E. Dixon. Revised by Dr. W. A. M. Smart. (Messrs. Edward Arnold and Co., London), 8th Edition, 1936. Pp. 483. Price 18*s*. net.

The *Manual of Pharmacology* by Professor W. E. Dixon is one of the most popular textbooks on the subject and the appearance of a new edition after an interval of seven years will be welcomed by both teachers and medical students. With the development of improved experimental methods and laboratory technique, pharmacology has made a remarkable progress during recent years. It was only natural, therefore, that in order to include all the newer knowledge a number of sections in the new edition should be rearranged and recast. This task has been very effectively and successfully carried out

by Dr. Smart. Although at first sight the book may appear to be a new one and not a new edition, careful perusal gives ample evidence of the personality of the old master.

The introduction of chemical formulæ and the attempt to bring into prominence the relationship between chemical constitution and pharmacological action are features evident to the most casual reader. Another innovation is the addition of a classified list of materia medica at the end of each chapter. A number of chapters, *e.g.*, hypnotics, uterine drugs, respiratory drugs, etc., have been thoroughly rewritten and brought up-to-date. The newer conceptions with regard to nature of action of eserine and cholinergic drugs have been included. Classification and arrangement of the subject-matter appears to have been done with great care and number of useful tracings have also been added.

The book is bound to create a very favourable impression and one may confidently hope that this edition would continue to maintain the useful purpose which its predecessors did for over a couple of decades.

R. N. Chopra.

The Microscope. By Simon Henry Gage. (Comstock Publishing Company, Ithaca, New York), Sixteenth Edition, 1936. Pp. viii + 616. Price $ 4 net.

This revised and greatly enlarged edition of Professor Gage's work will be invaluable to beginners and advanced students of biological laboratory practice. The book deals in a simple and direct language with the general principles of microscopy, profusely illustrated by well-chosen figures. The methods of latest technique for the preparation of material for microscopic examination are fully treated and the needs of research workers receive ample consideration. Chapters III, VI and XIV, which treat of dark-field microscopy and its application, the ultra-violet microscope and physical analysis and micro-incinerations and the optical applications for their examination respectively, are full of interest. As an aid in resolution, the dark-field microscope has a greater advantage over bright-field illumination, by the absence of glare and flooding, the whole aperture of the objective being filled by uniform light. Objects which are not sufficiently clearly resolved by transmitted illumination can be resolved by dark-field illumination with greater precision. Many useful hints regarding condensers, cover slips, lighting and lamps, preparations of objects are given in Chapter III. The ultra-violet microscope is a valuable aid in the physical analysis of objects under examination, and it is becoming increasingly necessary for acquiring as complete and detailed a knowledge of the structure and function of the tissues as the light radiations and lenses permit. Chapter VII gives an account of the general principles of the ultra-violet microscope and directions for its use in the examination of microscopic preparations. The chapter on Micro-incinerations gives the method by which the mineral salts in the fixed tissues can be studied, together with a detailed account of the optical appliances for such study. From the nature of the material, a dark field is almost a necessity for the study of the ash after micro-incineration and the special apparatus employed in the investigation include Policard-Scott Micro-incinerator, and uranium glass for showing the form and path of light beams.

Each chapter concludes with a list of reference works for collateral reading and the whole book is profusely illustrated. The final chapter gives a brief history of lenses and microscopes.

This sumptuous book is indispensable to biological students and research workers, and is an extremely important contribution to the theory and practice of microscopy.

Rutley's Elements of Mineralogy. By H. H. Read, (Thomas Murby & Co., London), 1936. 4th Edition. Pages viii + 490 + 12. Price 8*s*.

This is the fourth edition of Rutley's *Mineralogy* which has appeared under the editorship of Professor Read since 1915. This edition has been so completely re-written and re-arranged that it is difficult to find any resemblance to Rutley's original *Mineralogy*, but the courtesy title remains in admirable memory of that great mineralogist.

The needs of the student, and especially of those who will be more interested in the economic side of mineralogy, are kept constantly in view throughout. The book commences with a description of those chemical

properties by which minerals may be identified; these are, of course, the usual blowpipe tests which it is believed, all good prospectors should know. Some day, perhaps, a text-book on mineralogy will appear describing those micro-chemical tests on which minearls can be so simply and rapidly determined even by the most junior of students. The reader is led in Chapetr II through the various macroscopic properties which aid in mineral diagnosis—logically, perhaps, this second chapter should be first, but Professor Read's arrangement is essential as mineralogy is founded on the principles of chemistry. A reference in this second chapter to the ease with which hardness and cohesion may be confused would be desirable—the true hardness of a mineral is often far greater than its apparent hardness, hematite and pyrolusite being apposite examples. In Chapter III the elements of crystallography are simply and clearly told in sufficient detail, perhaps, for the elementary student. However, this reviewer would have liked to see this section treated even more fully, for crystallography is the most important branch of macroscopic mineralogy; in other respects mineralogy has gone far beyond the study of hand specimens. The microscope is now the most powerful weapon of attack; microchemical tests and the determination of refractive indices have become the foundation of diagnostic mineralogy. A brief note on the use of X-rays in crystallography might have been usefully inserted. Mineral optics receives excellent treatment, particularly as its practical application in determinative mineralogy is so well brought out and stressed. The uses of the petrological microscope are outlined and a few words are said about the reflecting microscope. Part I closes with a chapter on the mode of occurrence of minerals, completing a clear picture for the student of the place of minerals in nature.

Part II is entirely devoted to the description of minerals. The classification adopted is quite new, the economic significance of mineralogy being further emphasised by arranging the minerals primarily according to the useful elements present in them, and grouping them in the order of the Periodic Classification. Only the more important minerals are described; some of us may not agree as to which are the most important! The mode of occurrence and uses of each mineral are briefly sketched, a most excellent feature of the book. In some cases production statistics are given for recent years, helping the student to a clearer conception of the mineral industry. Some of Professor Read's descriptions of the mode of occurrence of certain minerals may not be acceptable to many economic geologists to-day; one example is his reference to certain copper deposits which he classifies as pneumatolytic and pyrometasomatic. A few of the descriptions suggest that Professor Read has not entirely kept up to date in his reading of the literature. It is a little depressing to the microscopic mineralogist to see limonite still described as a mineral with the formula $2Fe_2O_3\ 3H_2O$, to note the absence of any reference to water adsorption in the variety of hematite known as turgite, and to read that pyrrhotite often contains nickel and cobalt. This reviewer has found, at least in India, that misconceptions such as this, once acquired by a student, are very difficult to eradicate even when he becomes a graduate. An idea of microscopic inclusions and intergrowths should be given clearly in even elementary text-books, and it should be stated that such materials as titano-magnetite are mixtures and not minerals. However, there is apparently a long way to go before English mineralogy begins to appreciate the significance of ore-microscopy. Notwithstanding such occasional defects in precision this reviewer is of the opinion that Professor Read's latest edition of Rutley's *Elements of Mineralogy* is the finest text-book of elementary mineralogy which has yet appeared and is certainly the most suitable for the needs of students in India.

J. A. DUNN.

Historical Introduction to Chemistry. By T. M. Lowry. (Macmillan & Co., Ltd., London), 1936. Pp. ix + 581. Price 10*sh*. 6*d*.

This is the second edition of the late Prof. Lowry's well-known book, the first edition of which appeared in 1915. All the material included in the earlier edition has been preserved intact. In addition, a brief mention has been made of modern work on isotopes, the elements, hafnium and ilinium, etc.

The book provides within a reasonable compass an excellent introduction to historical chemistry.

M. SESHAIYENGAR.

Soil Erosion and its Control.

[*Soil Erosion and its Control* by Q. C. Ayres. (McGraw-Hill Publishing Co., New York and London), 1936. Pp. 365. Price 21*sh.*]

THE attention of the whole American nation has within the last 3 years been concentrated upon the disastrous effects of disforestation and careless field cultivation in destroying the fertility and dispersing the substance of their soil. Years of propaganda and small-scale demonstrations carried out by a small band of far-seeing enthusiasts has suddenly borne fruit in the creation of a vast federal government organisation, the Soil Conservation Service, which in an amazingly short time has established big demonstration projects in practically every state. These projects are staffed by men who have had previous experience on the land and some special training in soil conservation or counter-erosion work, the original cadre being mostly recruited from the forest service and from agricultural engineers.

These activities have resulted in a vast output of printed matter, mostly publicity pamphlets, newspaper articles, addresses to learned societies, leaflets and bulletins to farmers, etc., but the men who could have written a comprehensive text-book on the subject were all much too busy organising new developments, which reminds one of the quip: "An American acts then thinks, an Englishman thinks then acts, and a Chinaman thinks, and goes on thinking!"

Many of the American universities and State colleges have extended their forestry and agriculture courses to provide for the training of this new army of soil conservation workers, and the book under review is a students' text-book written by the Professor of Agricultural Engineering in the Iowa State College at Ames, Iowa. This State is in the northern half of the Middle West farm belt with a rainfall of about 30 inches with light soils and very gentle gradients, in fact ideal country for wheat farming, but its productivity has been very seriously reduced by wasteful farming methods, which have allowed the valuable top-soil to be washed away into the Mississippi River. Professor Ayres' book gives an excellent general account of the erosion situation in the United States and ably summarises the mass of scattered literature which has already been printed, but the bulk of the book consists of detailed recommendations for the construction of field terrace and soil-saving dams which in pattern, scale, and labour methods are not directly applicable to Indian conditions.

A short introduction is devoted to object lessons from erosion already reported from other countries, but this might have been made much fuller and more convincing in view of the world-wide attention which is now being directed to this subject. China, of course, is the great historic instance of utter impoverishment and denudation which followed the destruction of her northern highland forests, but within recent years fresh material from archæological research has proved more or less conclusively that the great Aztec civilisation of Central America passed away as a direct result of desiccation and erosion following upon clearance of tropical jungle on a big scale. India itself provides many concrete instances, such as Alexander's historian's report of great stretches of forest between Jhelum and Peshawar, and the Moghal historian's account of the siege of Nurpur, Kangra, carried on "in forests so dense that a bird could scarce stretch its wings," where now there is hardly a tree for a bird to nest in. Many of the African colonies are taking up erosion control on a considerable scale and Australia is also starting, though much damage already done is irrepairable.

In his discussion of the causes and effects of denudation of the existing plant cover as a contributory factor in erosion, the author brings out clearly the relative value of the various farm crops. He shows that soil loss is in direct ratio with the number of days for which a field is left with its soil surface uncovered by any crop—for instance continuous corn (maize) with 207 days of uncovered soil is highly destructive, continuous wheat with 91 days finds a midway position, while a permanent sward of fodder grass is a real guarantee against erosion. In discussing the influence of forest cover, however, he is not so convincing; for instance he quotes figures from a mountain forest study by Bates and Henry at Wagonwheel Gap, Colorado, where the run-off of water and solid eroded material was measured from two comparable catchments, one of which was clear-felled. The figures showed an appreciable increase in erosion, but not to any spectacular amount. This is quoted as an example of "denudation,"

but actually the forest area felled was kept closed to grazing and recovered so quickly by the sprouting of aspen coppice shoots, that after only a few weeks' real exposure to the elements, the whole area was reclothed even more densely than before. The usual Indian conception of "denudation" entails the complete and permanent eradication of the natural plant cover through browsing and grazing, as well as felling of the trees, but Bates and Henry's figures are for a much less drastic operation and are therefore not a true picture of the amount of destruction actually wrought by complete denudation as we conceive it.

One method of reducing erosion from field crops which has been much taken up in the United States is strip cropping, *i.e.*, growing different crops in strips along the contour so that the cumulative surface wash from a very vulnerable crop can be reduced. Cotton, maize, tobacco and other clean-tilled crops expose the soil beneath them, but loss of soil incurred by growing these can to some extent be prevented by interspersing strips of clover, lucerne, charri and other sorghums, wheat, barley, oats, fodder grasses or any other crop which makes a fairly good protective cover. In Indian practice it is of course essential that to be effective these must be fully established and in plentiful leaf before the onslaught of the monsoon rains, for it is then that protection of the soil is so essential. The Americans have experimented and measured every imaginable combination of crops suitable for each of their climatic regions in order to ascertain which gives most protection for a maximum area of cash-producing crops. The lesson should be applied in India, but a special technique suitable for our very small fields will have to be worked out; the usual Indian closely terraced rice fields probably are unbeatable for preventing run-off, but other crops on sloping lands leave much to be desired. Improvement along this line will have to provide for popularising cut-fodder crops because these are amongst the best soil protectors.

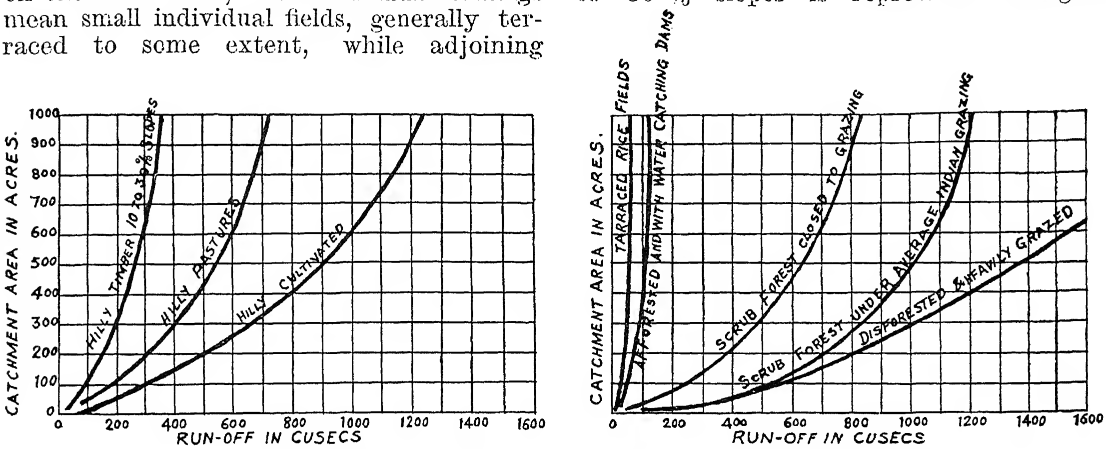
The use of contour-terracing either of stone or turf walls or ploughed earth ridges (the latter known in the Punjab as *watt bandi*) is already well known in many parts of India, though unfortunately it is not sufficiently practised. The use of the American broad-based terrace which does not interfere with ploughing is excellent where big single fields of uniform slope have to be broken up into smaller catchment units, but is not generally applicable in Indian field crops. It should however prove of very great value in the improvement of gently sloping grazing grounds; the response of grass to the extra share of moisture caught and held by such broad-based terraces is most marked, and if only some of our village grazing grounds on gentle slopes could be closed to grazing and contour-ridged for growing cut-fodder, the gain both in reducing run-off and in conserving cattle food would be considerable. The author advocates contour-ridging in pasture land, but he has omitted a very necessary note of warning, namely, that for ground open to heavy grazing contour-ridging on anything more than very gentle slopes, of say 1 in 10, is bound to lead to concentration of run-off and consequent erosion.

Probably the most useful section of the book for Indian practice is that on the planning and construction of soil-saving and water-catching dams. In Gurgaon and many other waterless tracts of isolated low hills there is a great future for water-catching dams of earth or stone, but they must be well placed and scientifically constructed, especially as regards the escape channel for leading away the surplus water when it threatens to overflow. Useful tables are given for calculating the size of such dams and their outlets, based upon the expected maximum run-off from serious storms. The actual figures for run-off for different slopes and types of plant cover are copied from C. E. Ramser's well-known data, now in common use amongst American soil conservation workers. These would need to be used with great caution if applied to Indian conditions, firstly, because individual storms in India will exceed even the semi-tropic south-eastern region of the United States in concentrated intensity and in cumulative heaviness. Secondly because Ramser's graphs show pasture land as giving considerably less run-off per acre than cultivated ground on a similar slope; in India it is generally the reverse, partially terraced cultivation giving decidedly less run-off than grazing ground of the same slope. This epitomises the essential difference in conditions between the two countries; in the United States cultivation is in big fields so that long unbroken slopes of bare plough land give much heavier run-off than do the comparatively well clothed

pasture fields grazed in a rational manner, generally on a definite rotation. In India, on the other hand, small individual holdings mean small individual fields, generally terraced to some extent, while adjoining grazing ground is so persistently over-grazed that it is left completely exposed to sheet erosion.

To make this position clear, Ramser's graph giving his empirical figures of run-off for different sizes of catchments of from 10 to 30 % slopes is reproduced alongside similar curves for Indian conditions, though our information for the latter is unfortunately very meagre.

R. MACLAGAN GORRIE.



Ramser's curves for average American conditions giving maximum expected to be exceeded once every 10 years.

Similar curves for Indian conditions based on very meagre Punjab Foot Hill Data.

Fig. 1.
Comparative run-off for American and Punjab conditions.

OBITUARY.

Mr. Dev Dev Mukerji (1903–1937).

WITH deep regret we record the death of Dev Dev Mukerji, Technical Assistant in the Zoological Survey of India, which took place at Calcutta on Thursday, the 21st of January 1937, after a brief illness, at an early age of 34 years.

Dev Dev Mukerji was born in January 1903 at Kharda in the 24-Parganas and after his early education at the village school he was sent to H. C. E. School at Andul from where he passed his Matriculation Examination. In 1919, he joined the St. Xavier's College at Calcutta and four years later passed his B.Sc. Examination with honours in Zoology. In 1925 he took his M.Sc. degree of the Calcutta University in Zoology, and in 1926 joined as an Assistant in the Zoological Survey of India.

Mukerji had a special aptitude for research and a year after his joining the Zoological Survey he published his first paper on two "Pug-headed" specimens of a catfish. Afterwards he worked on several collections from different parts of India in collaboration with the officers of the Department or independently. He was also a keen field zoologist, as is clear from some of his papers.

Mukerji was very methodical, thorough and painstaking in his work and made a very critical study of the data he collected. His published papers show what a commendable amount of research work, besides his heavy routine duties, he was able to do within a short period. At the time of his death he was engaged in preparing a *Bulletin* on Indian freshwater fishes for the Malaria Survey of India, a task of considerable responsibility.

Dev Dev Mukerji was a man of great personal charm and broad sympathies. He was liked by his superiors and colleagues, and in him the Zoological Survey has lost a very able and thoroughly reliable assistant. The science of Zoology, especially ichthyology, has become much poorer to-day by his premature death.

SUNDER LAL HORA.

CENTENARIES

S. R. Ranganathan, M.A., L.T., F.L.A.
University Librarian, Madras

Gellibrand, Henry (1597–1637)

HENRY GELLIBRAND, a seventeenth century mathematician of England, was born in the parish of St. Botolph, Aldersgate, London, on November 17, 1597. His father, Henry Gellibrand, M.A., was a Fellow of All Souls' College, Oxford, and died before the son entered the University. Gellibrand became a commoner of Trinity College, Oxford, in 1615 and took the M.A. Degree in 1623. Thereafter, he took holy orders and entered upon church work.

Change of Career

In the meantime, Sir Henry Savile had founded in 1619 two professorships at Oxford—the Savilian Professorship of Geometry and the Savilian Professorship of Astronomy. Savile himself held the Professorship of Astronomy for some time. While hearing one of Savile's lectures, Gellibrand was so impressed with it and his interest in mathematics was so roused that he gave up his curacy and decided to devote himself entirely to mathematics. He settled at Oxford and became a friend of Henry Briggs, of logarithms fame, who was then Savilian Professor of Astronomy. On the recommendation of Briggs, who was Professor of Geometry at Gresham College, London, till his arrival at Oxford, Gellibrand was appointed Professor of Astronomy at Gresham College in 1627.

His Publications

Gellibrand wrote several works. The chief of them are:—

(1) A discourse mathematicall of the variation of the magnetical needle together with its admirable diminution lately discovered.
(2) An institution trigonometricall.
(3) An epitome of navigation.

Trigonometria Britannica

But the most outstanding fame of Gellibrand as a mathematical author rests on the monumental publication entitled *Trigonometria Britannica*, which came out in two folio volumes in 1633. This was really a book left unfinished by his friend Briggs, when he died in 1630. In 1632, Gellibrand completed the book, adding a second part, all his own. A copy of this is available in the Royal Observatory. Gellibrand dedicated it to the electors to the Savilian Chair. From the preface, it is seen that Vlacq, another great enthusiast of the then newly discovered logarithms, took upon himself the cost of printing the work. It gives a table of sines for intervals of 0°·625 to 19 places of decimals and of log sines to 14 places. The work divides the quadrant into 90° but divides each degree into 100 equal parts. An English translation of Gellibrand's part of this book was published in 1658 as part two of his *Trigonometria Britannica or the doctrine of triangles* by John Newton. A copy of this also is available in the Royal Observatory.

Gellibrand died of fever at London on 16th February 1637.

Turner, Edward (1798–1837)

EDWARD TURNER, the British chemist, was born in Jamaica in July 1798. He studied medicine at Edinburgh and graduated M.D. in 1819. Thereafter, he went to Gottingen and studied chemistry for two years under the celebrated analytical chemist Stromeyer. He returned to Edinburgh in 1824 and became a lecturer in chemistry. In 1828, when the University of London was founded, he obtained the Professorship of Chemistry in the University College and continued to hold it till the end of his life.

His Publications

In his short career, he published forty papers, most of which appeared in the *Edinburgh journal of science.* The readers of *Current Science* may be particularly interested in a paper of his published in Vol. 9 of that journal in 1828 under the title *Analysis of the solid contents of two hot mineral springs in India.* In 1825, he brought out a short but clearly expressed *Introduction to the study of the laws of chemical combination and the atomic theory.* His *Elements of chemistry* which first came out in 1827 and went through eight editions was remarkable for the comprehensive and lucid manner in which the whole science of chemistry was expounded. He

also contributed the mineralogical articles of the *Penny cyclopædia* published for the Society for the Propagation of Useful Knowledge.

HIS CONTRIBUTIONS

His chief interest was in inorganic chemistry. He employed himself especially in perfecting the atomic theory. It was through his labours that the equivalent numbers of many of the elements were established. He was elected F.R.S. in 1831.

HIS END

In early life he was subject to disease of the lungs. In 1835, he was compelled by the declining state of his health to suspend all original researches. In January 1837, he was seized with inflammation of the lungs and died at his residence at Hamstead on February 13, 1837, to the deep regret of every friend of the progress of chemistry. He is said to have been a person of most engaging manners and appearance and of most amicable character, and his body was followed to the grave, with every manifestation of respect and affectionate attachment by the whole body of the pupils and professors of the University College, London. A marble bust of him was placed in the library of the College, the cost being defrayed by subscriptions from his pupils.

Mascart, Eleuthere Elie Nicolas (1837–1908)

MASCART, the French physicist and meteorologist, was born at Quarouble on 20th February 1837. He had his education at Ecole normale superieure. He became a Doctor of Science in 1864. Having been successively Conservator of the Collections in the Ecole normale, Professor of Physics in the Lyce de Versailles and the College Chaptal and having acted on several occasions as a Deputy to Professor Regnault at the College de France, he succeeded to the chair of Regnault in 1872. Later, in 1878, he became the Director of the Central Bureau of Meteorology in Paris. This post he held till his retirement in 1907.

CONTRIBUTIONS TO SPECTROSCOPY

He was a prolific writer. He has to his credit more than 120 papers. His first few papers were on spectroscopy, the very first entitled, *Determination de la longueur d o'nde de la race A*, having appeared in *Comptes rendus* in 1863. He was one of the first to apply photography to the study of spectra. He devised a novel optometer and studied the distribution of colour sensation over the retina of the eye. Between 1874 and 1878, he made elaborate studies in the refraction and dispersion of gases. He investigated Doppler's theory and reached the conclusion that optical phenomena give no indication of the absolute motion of a body but only of its relative motion. This result earned for him the Grand Prix de Sciences Mathematiques in 1874. The culmination of his contribution to optics is his elegant *Traite d'optique* published in four volumes, in 1890–93.

CONTRIBUTIONS TO ELECTRICITY

Next, Mascart turned his attention to electricity and magnetism. Through his *Traite d'electricite statique 2 V.* published in 1876, he introduced Green's theory of potentials to the students of physics in Europe. He took a leading part in the determination of electrical units. The Electrical Exhibition and the International Electric Congress of 1881 brought him to the forefront in the debates on electrical units. His determination of the electrochemical equivalent of silver was accepted as the standard.

CONTRIBUTIONS TO METEOROLOGY

As the Director of the Central Bureau of Meteorology in Paris for nearly thirty years, he succeeded in the face of numerous difficulties in gradually perfecting the equipment and organisation of the Bureau and in establishing the systematic publication in France of weather charts and weather forecasts. He published several *Bulletins* and *Observations* as the director. He early made his mark in the scientific study of meteorology. His observations in 1875 contributed largely to the conclusion that in the development of fogs and clouds, the presence of dust was essential.

HIS HONOURS

In 1884, he was elected to the Academie des Sciences, of which he became President in 1904. He assisted the Government in various committees and bureaus and in recognition of his public services, he was created Grand Officer of the Legion of Honour. He was the President of the Electrical Congress of 1900. He was also an honorary member of several foreign learned bodies and was the President of the International Meteorological Committee from 1896 to 1907.

He died at Poissy on August 26, 1908.

INDUSTRIAL OUTLOOK.

The Hydrogenation of Coal.

By Kenneth Gordon.
(*Imperial Chemical Industries, Limited, London.*)

The Chemistry of Hydrogenation.

DURING the last twenty years a feature of chemical industry has been the large-scale development of a new and powerful tool in the shape of high pressure hydrogenation. The first application was the synthesis of ammonia from nitrogen. This was followed by the conversion of carbon monoxide to methanol. The latest development of the process is the liquefaction of coal to form petrol, or indeed almost any oil product.

The hydrogenation of coal is, in fact, a destructive hydrogenation process, in which hydrogen is made to react with the coal at a temperature sufficiently high to break down the large and complicated molecules of the coal substance. The essential parts of the reaction are that coal is subjected to the action of heat and of high pressure hydrogen in the presence of catalysts.

The main function of the high temperature is to effect the well-known cracking reaction which simplifies the molecular structure of the coal and produces molecules of the size required.

The main function of the high pressure hydrogen is to increase the yield of the desired product by preventing coke formation. When coal is heated in the absence of hydrogen, the large coal molecules, which contain relatively little hydrogen, are broken down into smaller molecules, some of which are richer in hydrogen than the original coal molecules, and some are poorer. Those that are richer form the yield of light oil and petrol, together with a certain amount of gas containing still more hydrogen, the formation of which may not be desired but always takes place to some extent. The molecules that are poorer in hydrogen, being highly unsaturated, polymerise rapidly to form coke and heavy oils. On simple application of heat, therefore, it is clear that the yield of a desired light oil product of relatively high hydrogen content is limited by the hydrogen content of the coal treated. When bituminous coal is heated, for example, about 80 per cent. of the pure coal substance is converted to coke.

When the heating of the coal is carried out in the presence of high pressure hydrogen, however, coke formation can be avoided, since unsaturated molecules react with hydrogen so that polymerisation is prevented and the yield of light oil products is increased enormously.

A further effect of the hydrogen is to remove the undesired oxygen, nitrogen and sulphur which are present in coal in chemical combination with carbon and hydrogen. These are converted by the hydrogen into water, ammonia and sulphuretted hydrogen, which are subsequently separated in the form of an aqueous solution. (Fig. 1.)

The function of the catalysts is to accelerate the desired reactions. Various catalysts are used in practice, all of which favour, in general, both the cracking reaction and the addition of hydrogen, but to different relative extents. The choice of catalyst depends on the nature of the raw material and of the desired product.

Hydrogenation may be effected either in the liquid phase or in the vapour phase.

Liquid phase reaction is employed when hydrogenating coals or heavy oils. In treating coal, for example, it is first finely ground and mixed with heavy oil, and the mixture is heated and introduced together with hydrogen into a reaction vessel, the suspension of the coal in oil being kept agitated by the stream of hydrogen bubbling through it. Catalysts are introduced in the form of powder either mixed with the original coal or injected separately as a suspension in oil.

Vapour phase reaction is used in the treatment of lighter oils which, in the presence of hydrogen, are completely vaporised at the reaction temperature. In this case the heated oil vapour is passed, together with hydrogen, over solid catalyst in the reaction vessel.

It is by altering the conditions of the reaction that such varied feed materials may be treated by hydrogenation to give varied

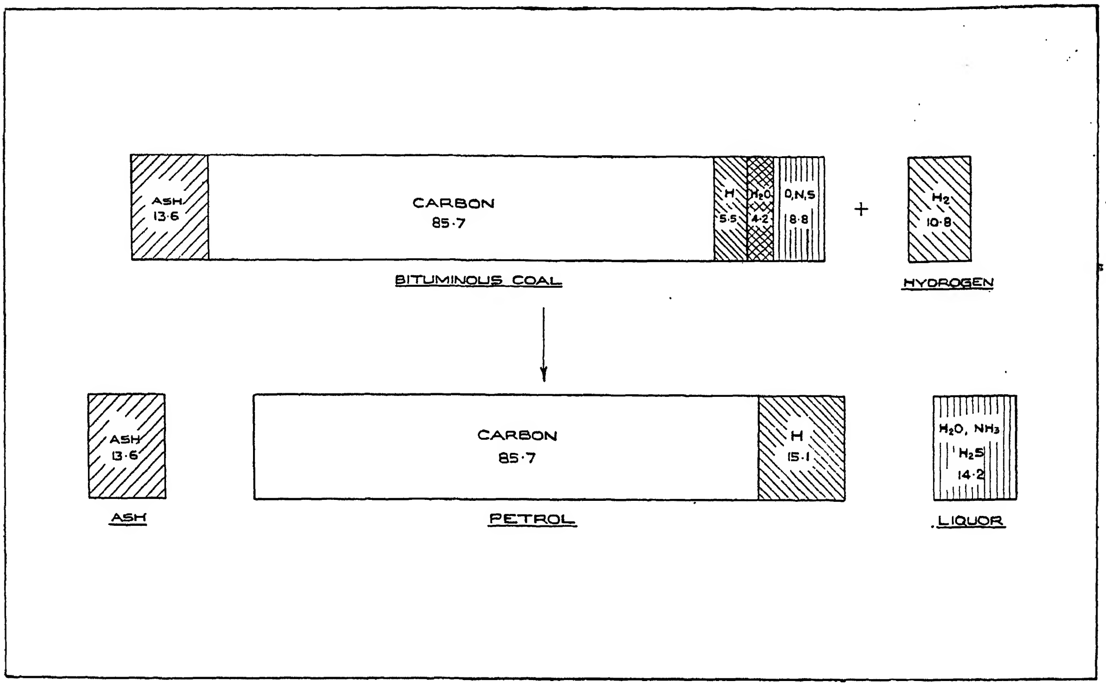


Fig. 1.

The Conversion of Coal to Petrol by Hydrogenation.

products. In general, lower temperatures tend to give more saturated products containing more hydrogen than those obtained at high temperatures, since the latter favour the cracking reaction at the expense of saturation with hydrogen.

Thus, by working in the liquid phase at a low temperature of about 400° C., heavy oils can be hydrogenated without much cracking, and in this way, for example, lubricating oils can be improved in quality.

In the vapour phase, similarly, by working at low temperatures crude petrol can be refined without much cracking and middle oils can be gently hydrogenated to form kerosene. By working with high temperatures of above 500° C. and with suitable catalysts, petrols with exceptionally high anti-knock properties can be produced.

However carefully the reaction conditions for any particular hydrogenation reaction are chosen, it is impossible to avoid the production of a certain quantity of gas during the cracking reaction, particularly at high temperatures. Although gas formation does not altogether represent a loss of efficiency in that the gas, consisting largely of methane and ethane, can be reacted with steam to give the major part of the hydrogen requirements of the plant, it does, nevertheless, represent a loss of oil output which must always be considered when choosing the most suitable conditions of catalysis and temperature for any particular hydrogenation reaction.

In producing petrol from coal it is possible to obtain a yield of petrol by direct liquid phase hydrogenation. It has however been found to be greatly preferable to work with a two-stage process, the liquid phase reaction being followed by a secondary vapour phase reaction in which middle oil formed in the first stage is hydrogenated to petrol. In some circumstances it is economic to introduce an intermediate stage to convert heavy oil formed in the original coal hydrogenation stage into middle oil.

Principles of a Large-scale Coal Hydrogenation Plant.

It is generally economic to remove a portion of the ash in the coal before introducing it to the high pressure hydrogenation plant. This may be effected by any one of numerous well-known processes, for example,

air elutriation followed by flotation on well-agitated sand and water mixtures. In working with brown coal it is advisable to remove the water content by drying.

The coal is finely ground and mixed with an equal weight of circulating heavy oil returned from a later stage in the process. This results in the formation of a coal paste, which is a suspension of coal in oil and which, at the temperature employed, is fluid and can be readily handled in pipe lines and pumps. The paste is fed to hydraulically operated pumps which deliver it at a pressure of 250 atmospheres through high pressure pipes to the reaction unit.

The reaction unit consists of interchangers, preheater, reaction vessels known as converters, cooler and catchpots or separators (Fig. 2). The coal paste is joined by a stream of high pressure hydrogen, after which the combined mixture is heated to reaction temperature (400–500° C.) by passing through the interchangers and preheaters. In the interchangers, which are in general, of the tube-stack type, the cold feed is partially heated by heat exchange with the hot products leaving the converters. In the preheater it passes through tubes which are heated by the hot gases from a fuel gas burner.

The heated mixture then passes to the converters, of which there are generally two or more, arranged in series.

The converters consist of large forgings (height 45 feet, diameter 6 feet, for example), enclosing reaction vessels, the combined volume of the latter being sufficient to give the required time of reaction. The internal reaction vessel is separated from the external forging by insulation. Consequently the internal vessel withstands the reaction temperature but no pressure, and the external forging withstands the 250 atmospheres pressure but not a high temperature. This design obviates the use of special steels for the heavy forgings.

The hydrogenation reaction which takes place in the converters is highly exothermic, and these vessels are consequently fitted with thermocouples for the measurement of temperature, and suitable means for control.

The catalysts required for the reaction are either added in the form of powder to the original coal paste or injected separately

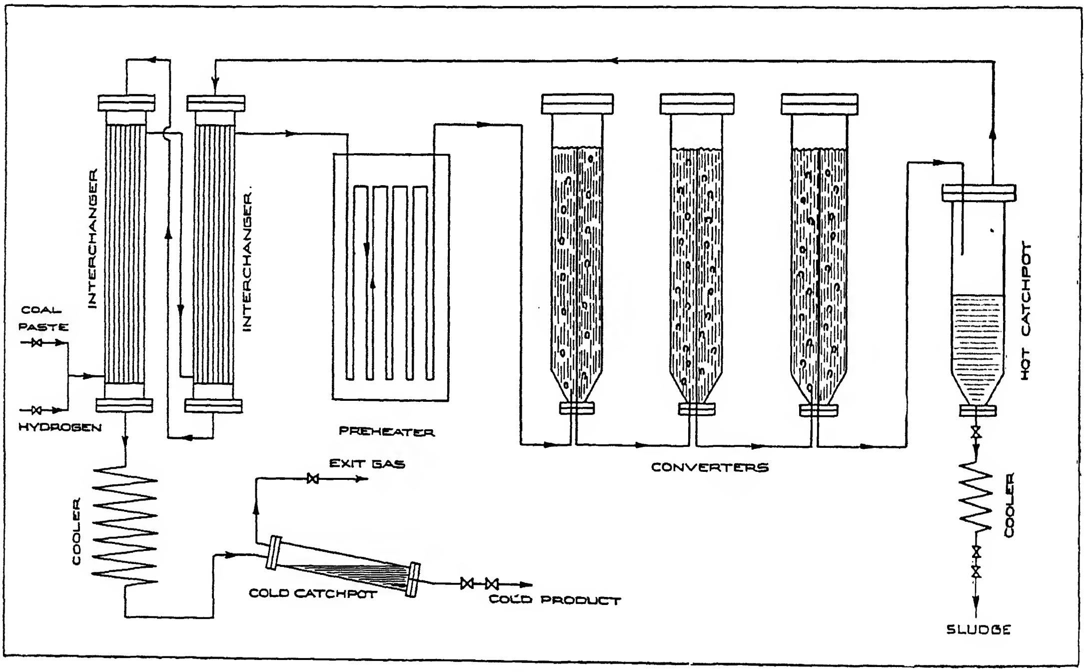


Fig. 2.
Diagram of Full Scale Hydrogenation Unit.

at some point in the system in the form of a suspension in oil.

On leaving the converters the products pass immediately to the hot catchpot. This is a separator which is maintained only a few degrees lower than the reaction temperature, and in which separation is made between the vaporized and non-vaporized products of the reaction. The non-vaporized product is a sludge which contains the ash content of the original coal, unconverted coal and heavy oil. This sludge is cooled, released from pressure and treated by centrifuging and a special carbonisation process to recover its oil content and give a small purge from the reaction system of ash introduced with the coal feed and of unconverted coal. The purge is obtained in the form of a low grade coke which is employed as a boiler fuel. The oil recovered from the sludge is recirculated to form part of the oil used for pasting the coal feed. Any sludge which is not subjected to this oil recovery process is recirculated directly and used for making coal paste.

The main products from the reaction leave the hot catchpot in the form of vapour and pass through the interchangers and cooler, after which, at atmospheric temperature, they enter the cold catchpot where there is a further separation between liquid and vapour or gas.

The gas fraction from the cold catchpot consists mainly of hydrogen accompanied by hydrocarbon gases formed by the undesired extreme splitting reaction in the converters. The hydrocarbons are largely removed by passing the gas together with high pressure oil through a wash tower, and the purified hydrogen then passes to compressors where it is boosted to its original pressure and recycled to the reaction unit.

The liquid fraction from the cold catchpot is the main product from the reaction. It is released from pressure and passed to storage tanks where it is allowed to stand for several hours to separate an aqueous layer containing water, ammonia and sulphuretted hydrogen formed from the oxygen, nitrogen and sulphur in the original coal.

The oil product is then pumped to a distillation plant where it is fractionated into a heavy oil, a middle oil and a petrol.

The middle oil fraction is further hydrogenated to form petrol in a vapour phase reaction unit (containing interchangers, preheater, converters, cooler and catchpot), similar to the reaction unit used for the hydrogenation of the coal paste, but differing from it in that the converters contain solid catalysts suitably supported and there is no hot catchpot since the entire product is vaporized at the reaction temperature. The oil product from this reaction unit is finally fractionated in the distillation unit to give petrol of the desired volatility and a middle oil fraction which is returned to the reaction.

The heavy oil fraction from the distillation of the product from the coal hydrogenation unit is recirculated and used for pasting the coal feed.

In some circumstances it is found economic to operate the coal reaction unit to produce more heavy oil than is required for mixing with the coal feed. The excess heavy oil is then hydrogenated in a secondary liquid phase reaction unit similar to the first. The oil product is fractionated at the distillation plant to give heavy oil, middle oil and petrol fractions. The heavy oil is recirculated to the liquid phase reaction, and the middle oil passes to the vapour phase reaction.

A diagrammatic flowsheet of the bituminous coal hydrogenation plant at Billingham, which includes a secondary liquid phase reaction unit, is shown in Fig. 3.

The major part of the petrol output of the plant is obtained from the product of the vapour phase reaction unit. It is immediately washed with caustic soda to remove sulphuretted hydrogen, but requires no further refining treatment. Petrol from the liquid phase reaction units is refined by washing with caustic soda and sulphuric acid, followed by redistillation.

Hydrocarbon gas, formed by the undesired extreme cracking reaction in the converters, is formed as a by-product. The gas is evolved when pressure is released from the wash-oil used to purify the hydrogen leaving the reaction units, and from the main oil products from the reaction units. The richest part of it contains a petrol fraction which is removed in an absorber and stripper at the distillation unit. Butane or propane may also be removed from it and sold in

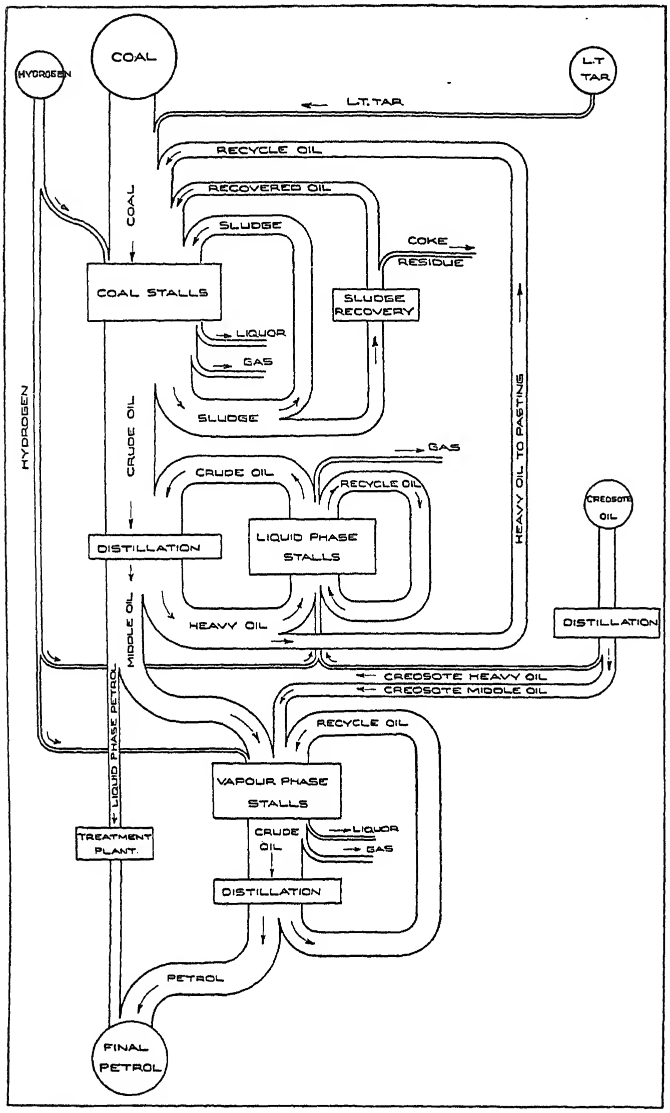


Fig. 3.
Flow Diagram of Billingham Plant for Hydrogenation of Coal, Creosote Oil and L.T. Tar.

cylinders for use as fuel gas. The remainder of the by-product gas may be used as a fuel gas on the plant, but is most useful for the manufacture of hydrogen by treating it with steam in the presence of catalysts, a process which was originally worked out by the I.G. and Standard Oil Company (New Jersey). In this way it is possible to provide the major part of the hydrogen requirements of a coal hydrogenation plant.

Further by-products which may be isolated separately or may, if desired, be further hydrogenated to form petrol, are phenol, cresol and high homologues.

HISTORY OF HYDROGENATION.

The original conception of producing oil and petrol from coal by hydrogenation is due to Bergius. Commencing shortly before the War he carried out numerous experiments in externally heated autoclaves. These eventually culminated in a small continuously operated plant at Rheinau, near Mannheim, which was operated until 1927.

The I.G. commenced experimental work on the subject after the War. They made two great advances; the discovery of catalysts immune to poisoning by sulphur, and the division of the reaction into liquid phase and vapour phase stages. In consequence they were able, in 1927, to build a large-scale plant at Leuna designed to produce 100,000 tons per year of petrol from brown coal. For the first few years the plant operated mainly on low temperature tar from brown coal and German crude petroleum. Since 1931, however, direct hydrogenation of brown coal has been the main source of output, and in the last year or two extensions have been made to the plant until at the present time the output is 325,000 tons per year of petrol.

In 1927, the I.G. entered into an agreement with the Standard Oil Company (New Jersey), and the latter then built two hydrogenation plants in America, which have been used for the production of petrol, special solvents, lubricating oils and kerosene.

I.C.I. commenced work in 1927, concentrating mainly on the production of petrol from bituminous coal, being the most suitable application of the hydrogenation process for conditions in England. They operated a large-scale experiment from 1929 to 1931 in a plant treating 10 tons per day of bituminous coal.

In 1931 the four major operators in the

field—namely, the I.G. of Germany, The Standard Oil Company (New Jersey), the Royal-Dutch Shell Group, and the I.C.I.,—associated themselves in a pooling company, the International Hydrogenation Patents Co., in order to pool their patent rights and to effect a general exchange of technical information, the I.C.I.'s interests being centred in the British Empire. At the same time arrangements were made for marketing products through existing oil-distributing Companies.

This pooling of technical resources on an altogether unprecedented scale has been uniformly beneficial, and the I.H.P. group is now pre-eminent technically and their patent position very strong. Even apart from the patent position it would seem imprudent to attempt to operate independently when there are available such great accumulated practical experience and technical resources as are possessed by the constituent Companies in the I.H.P. pool.

In 1935, I.C.I. started a large-scale plant at Billingham-on-Tees to produce 100,000 tons per year of petrol from bituminous coal and 50,000 tons per year of petrol from bituminous coal tars, the total output of petrol being 150,000 tons per year.

In 1934 while the above plant was being erected, the I.G. carried out a large-scale experiment on the hydrogenation of bituminous coal, which operated successfully for four months. A large-scale plant is starting this year (1936) at the Hibernia Colliery in the Ruhr, to produce 125,000 tons per year of petrol by the hydrogenation of bituminous coal. In addition, the Braunkohle-Benzin A.G. (Brabag) is now building two plants, one of which is now commencing operation, in which petrol is to be produced by the hydrogenation of low temperature tar obtained from brown coal.

Large-scale plants operating or about to operate the I.H.P. destructive hydrogenation process are detailed in the following table :—

The combined capacity of the above plants is 1,625,000 tons/year of petrol.

Products of Hydrogenation.

The flexibility of the hydrogenation-process is evident not only in the diverse natures of the various raw materials which can be used, but also in the varied types of products which can be obtained.

When the process is operated to produce petrol, for example, the knock rating and volatility of the petrol may be varied as desired within wide limits. The following table gives the more important properties of three types of petrol produced by the hydrogenation of bituminous coal.

"1" refers to a petrol obtained directly from coal stage reaction, and corresponds to the specification of a typical No. 1 spirit in England.

Firm	Place	Country	Raw Material	Date of Starting	Rated Annual Output Tons
I.G.	Leuna	Germany	Brown coal Brown coal tar Creosote oil German petroleum oil	1927	350,000
S.O.Co.	Baton Rouge	U.S.A.	Petroleum oil	1930	250,000
,,	Bayway	U.S.A.	,,	1930	250,000
I.C.I.	Billingham	Great Britain	Bituminous coal Creosote oil L. T. tar	1935	150,000
Brabag	(Two Plants)	Germany	Brown coal tar	1936	300,000
Hibernia	Scholven	,,	Bituminous coal	1936	125,000
A.N.I.C.	Bari and Livorno	Italy	Petroleum oil	under construction	200,000

"2" indicates a vapour phase petrol made up to a typical Ethyl Spirit specification with lead.

"3" is a leaded aviation spirit.

Properties of Petrol from Bituminous Coal Hydrogenation.

	1	2	3
Specific gravity	0·740–0·745	0·734–0·738	0·730
I.B.P.	35 deg. C.	35 deg. C.	35 deg C.
90 % vol. recovered at	158 " "	160 " "	150 " "
F.B.P.	170 " "	170 " "	165 " "
Residue	1·0 %	1·0 %	1·0%
Loss	1·0 %	1·0 %	1·0%
% Distillation + Loss at			
70 deg. C.	20 %	19 %	21 %
100 " "	40 %	40 %	50 %
140 " "	75 %	75 %	87 %
Reid Vap. Pressure at 100 deg. F.	9 lb.	9 lb.	7 lb.
Octane No. C. F. R. Motor Method	71–73	80	..
Octane No. C. F. R. Aviation Method	..	..	87
Colour	+ 25 Saybolt	Red	Blue
Odour	Marketable	Marketable	Marketable
Sulphur, % by weight	0·5	0·01–0·02	0·01–0·02
Doctor Test	Negative	Negative	Negative
A.S.T.M. Copper strip corrosion test	"	"	"
Gum, pyrex dish without air jet (mgm./100ml.)	2·0	Up to 3·0	Up to 3·0

Large-scale coal hydrogenation plants have so far been operated mainly to produce petrol as the main product. The process can, however, be altered to produce almost any other type of oil product. Thus the heavy oil obtained from coal forms an excellent fuel oil without further treatment. Diesel oil may be obtained by direct hydrogenation of brown coal, or by mild hydrogenation in the vapour phase of middle oil obtained by hydrogenation of bituminous coal.

Up to the present time very little work has been done on the production of lubricating oil from bituminous coal, but it is known that heavy oil made by the hydrogenation of brown coal may be converted into lubricating oil by further hydrogenation over a static catalyst. This process of hydrogenation with a static catalyst is used by the Standard Oil Company of New Jersey for the large-scale production from high boiling petroleum fractions of best quality lubricating oil rich in hydrogen and with a flat temperature-viscosity curve.

Loss of yield caused by extreme cracking reactions which form coke and gas are minimised, as mentioned before, by the high pressure hydrogen and comparatively low temperatures. Consequently yields are high. For example, the yield of petrol from bituminous coal calculated on an ash and moisture free basis is more than 60 per cent. by weight. The yield of petrol from tars and oils is 80–90 per cent. by weight.

The most important figure is the over-all coal consumption, including coal used for producing all the hydrogen and services necessary such as electric power and steam. For producing petrol from bituminous coal the over-all requirement per ton of petrol is 3·5 to 4 tons of raw coal, the exact figure depending on the ash and moisture content of the coal and its suitability for the process. Thus, the thermal efficiency is 40 per cent., which may be compared with the figure of 25 per cent. for generation of electric power.

The Insecticidal Properties of Kerosene and Lubricating Oil-Emulsions.

By U. S. Sharga.

(*Agricultural College, Cawnpore.*)

LIGHT oils having insecticidal properties have been known since 1897. The ignorance of the physical and chemical properties of the emulsions, and the want of standardization, have lately brought them into disrepute. Recently in Europe and America, a fresh impetus has been given to the use of heavy oils, specially lubricating oils and this is fast taking the place of lime-sulphur wash in dormant sprays for scale-insect control.

A few laboratory and field observations were therefore made with kerosene and lubricating oil-emulsions and the nature of their actions on a large number of insects including scale-insects was noted. Only a few oil-emulsions are effective against scale-insects. The insecticidal properties of oil-emulsions are dependent on the following factors:—(1) The manner in which the oil is mixed. (2) Kind and quantity of soap used. (3) Type of oil. (4) Composition of the water employed, and (5) Temperature of the emulsions used for spraying. All factors being similar, oils with 80–100 viscosity (resistance to flow, "Saybold test") are quicker to emulsify than those between 30–40 viscosity. The size of the globules in the emulsions determines their insecticidal property.

Stability.—Different sizes of emulsified oil globules have different properties, as is indicated by the work of Moore[1], Richardson,[2] Griffen and Burdette and English.[3] The less stable the emulsion, the greater is the amount of oil thrown to the surface of the spray-drops. In killing aphids the most effective emulsions are those which are relatively unstable and are good wetters. On the other hand, those emulsions which have a high wetting ability are injurious to foliage. Kerosene emulsion is a good wetter. The size of the emulsified oil globules are small and it effects a high kill of aphids. But it also burns the tender foliage if it is not made in the proper manner and proportion.

Viscosity and volatility.—The results obtained by De Ong[4] and English[3] in spraying against citrus scale and oyster shell scale may be taken as a fair indication of the effectiveness of oil emulsions against other scale-insects also. A spray of 60 viscosity and 5·3 per cent. volatility is not so effective as sprays of slightly higher viscosity and lower volatility. Kerosene oil of 32 viscosity and 35·1 per cent. volatility emulsified in sodium or potassium soap is ineffective (English[3]). For scale-insect control the oil should not, normally, be below 80 viscosity and should not have a volatility of over 1 per cent.

Wetting and spreading.—A good wetter is a good killer of insects owing to the physical and chemical reactions that it can produce on or inside the insect body. The spreading of the emulsified substance on insects is followed by killing. Aphids are not readily killed by sprays that do not wet them and wetting is secured by the addition of soap. Oil emulsified in tap water is not so stable as in distilled water and stability is one factor upon which depends the killing action of the oil emulsified.

Saturated and unsaturated oils.—The killing power depends upon the type of oil and the amount of emulsifying agent employed. The unsaturated oils may be more effective than saturated oils if the emulsion is of the unstable type. In controlling scale-insects, the action of an oil-emulsion is largely a physical one, that of suffocation. If death is due to penetration, the oils of low viscosity should be more effective, but high volatility is usually associated with low viscosity and if death is to be effected by penetration alone, the oils should persist for some time. The ineffectiveness of light oils has also been demonstrated by Moore[6] and Graham; these oils evaporate too quickly to cause penetration and death. According to De Ong,[4] scale-insects actually expel the light oils from their tracheal system. It is therefore better to use an emulsion that will release quickly an oil of sufficiently high viscosity and low volatility to give a residue that will persist for some time to cause death by suffocation. This is well supported by the observations made by the author on the lubricating oil-emulsions, *Castrol AA*.

Kerosene oil emulsion.—This emulsion was prepared with 1 oz. of sodium soap (Bar Soap), 10 oz. of water and 20 oz. of kerosene oil. Stock solutions were briskly agitated for 30 minutes and a sample was examined under the microscope. Oil globules of all sizes were found and there were numerous globules of small sizes contiguous with each other. When diluted six times (Temp. 30° C.) the oil globules were found scattered. Substituting soft soap for hard soap and keeping the same proportions, the emulsification was better and the globules were much more even in size and very closely packed; with dilution, they were scattered but still closely packed. The difference in the compactness of globules and their sizes is well marked in the two types of emulsions prepared with hard soap and soft soap. Light oils and soaps of known analytical characters should be employed for preparing the emulsions in order to obtain definite results. The size of oil globules formed is an important factor in the killing of aphids, jassids, etc. The small globules formed run well over the insect body dissolving the waxy coating if any and the death of the insect is almost instantaneous.

Lubricating oil emulsion.—*Wakefield Castrol AA* was used in preparing this emulsion. It is a medium-heavy oil with a B.P. over 240° C. The emulsion of this oil was prepared in the same way and with the same proportion of soap and water as with kerosene. Examination of the emulsion was made under the microscope. In this case the oil globules were of very large size, small globules were also present. When soft soap was used the emulsion was better; globules were contiguous and the size of the oil globules was small. On dilution the globules were scattered but their size was maintained. The volatility was remarkably low and the droplets showed a tendency to run together in a short time. With a fall of temperature an oil residue was invariably left and this is a highly desirable quality in scale-insect control. It can

be effectively used on various species of *Aspidiotus*. *Pulvinaria*. *Icerya*. *Lecaneum* and other coccids. In the control of these scale-insects, wetting power is not so much needed as the large size of the globules found in *Castrol A.A.* Several of the large size globules completely cover up the scale. causing death through suffocation. Besides. the emulsion from lubricating oil is not penetrating and not so dangerous to foliage as the kerosene oil emulsion. Lubricating oil is also not likely to cause canker of stems, branches and twigs and the future prospects of its use as sprays against scale-insects in India appear to be great. Detailed results on these will be published elsewhere.

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[1] Moore, *Univ. Minn. Tech. Bull.*, 1921, **2.**
[2] Richardson, Griffen and Burdette, *Jour. Agric. Res.*, 1927, **34.**
[3] English, *Illinois*, 1928, **17.**
[4] De Ong, *Jour. Eco., Ent.*, 1926, **19.**
[5] Stellwaag, *Zeit. Angew. Ent.*, 1924, **10.**
[6] Moore and Graham, *Jour. Agric. Res.*, 1918, **13.**

Biochemistry in Relation to Agriculture.

By Sir John Russell, D.SC., F.R.S.

"YOU. at the Indian Institute of Science, are engaged in a field which offers great opportunities to add to the richness of life, to alleviate human sufferings and to improve the lot of the millions of agriculturists in India; and I hope that the triumphs and achievements of biochemistry will further be improved by the work that you are doing at the Institute"—so declared Sir John Russell, Director of the Rothamsted Experimental Station, in concluding an interesting address on "Biochemistry in Relation to Agriculture" which he delivered under the auspices of the *Society of Biological Chemists* at Bangalore on December 15th, last.

Biochemistry, said Sir John, was the chemistry of substances concerned with life. In the early days of biochemistry that subject had been a distinct branch of chemistry and people had thought of life as entirely distinct from non-living things. That was the origin of the distinction between organic and inorganic chemistry, a distinction which still survived and caused confusion among students. In the second period of the study of biochemistry it was shown that substances with life could also be synthesised in the laboratories and that there was no fundamental difference between organic and inorganic substances.

Later still the difference became one purely of convenience in study. In reality the realm of nature was one and indivisible but they classified their studies into different groups because one could not study every field.

Agriculture.—Referring to agriculture, Sir John said. that one Professor had defined it "as something to keep away from". In his young days, he had been warned that there was no career to be made out of agriculture. He, however, held that there was a great deal in agriculture and that there was a close connection between agriculture and biochemistry. As a result of recent studies in biochemistry they had found it possible to define quality in relation to crops. In England, for example, quality problems in connection with crops were first studied in relation to barley which was used in the production of beer. Later, the studies in quality extended to wheat and it was found that there were three different kinds of wheat—one which was best adapted for loaves, another which was good for biscuits, and another which was good for macaroni. What was good for one purpose was not necessarily good for the other two. Biochemical study had been able to relate the composition of wheat in a general way with the question of its suitability to any purpose, but the details were still obscure.

In India they had a particularly important set of problems concerned with the food of the people, especially of the Indian ryot, who as they all knew, was the basic foundation on which the whole of this country was built. In order to arrive at the normal daily food available for consumption by the average ryot, Sir John had collected figures referring to the total crop production in India and found that the average consumption of grain by the Indian ryot worked out at about one pound per head per day. In the Punjab and in Bengal it was slightly over a pound, while it was slightly under a pound in Madras. Curiously enough, these figures tallied closely with those for consumption furnished by the ryots themselves whom Sir John had interrogated. The normal food of the ryot in the Punjab consisted of fifty per cent. wheat, thirty per cent. gram and the rest of cereals. That would furnish a diet very rich in protein. In Bengal the diet was very poor in protein, as it was almost wholly composed of rice. In Madras they had an intermediate sort of diet, rice accounting for 70 per cent. and the rest being made up of protein foods.

Protein Content of Grain.—There is great need for the determination of the nature and amount of proteins present in the common grains in use in India. They knew the protein contents of wheat and barley but they wanted more information than was available now, about the proteins of Indian grains. Till that study was completed they could not say how the daily diet of the Indian ryot could be improved. Agriculturists could not be expected to know what foods to grow from a dietary point of view.

What was the source of vitamins for the Indian ryot and agriculturist? In an Indian village, he had met an old man who could not say how old he was, but was obviously above 70 years. If one could accept his own account of his diet, he would have had very little of the vitamins A, B, C, or D. That would constitute a biochemical mystery making one wonder whether by some physiological process the Indian ryot had evolved the secret of protecting himself, against deficiencies of vitamins in his food. Scientists, perhaps, in an effort to explain it away, would fall back upon the abundance of brilliant sunshine

which they had in India. Sir John felt that there was a great deal in it and that the abundant sunshine might somehow or other make it unnecessary for the Indian ryot to have as much vitamin supply as was needed in less sunny countries.

That did not, however, mean that there was no room for improving the diet of the Indian ryot. That could and should be improved. That problem could be solved only after they had solved the biochemical problems relating to Indian food products.

Livestock Problems.—Sir John then referred to the conditions of animal stock in India and said that everywhere in India, poor stalks of grain crops, and poor grazing fields provided the main food for cattle. That was an inadequate diet for animals. There was a great need to radically improve the dietary of animals both in quality and in quantity. He was glad to note that at the Animal Husbandry Conference held in Madras, they had on the previous day (December 14) emphasised that point. The bullock was the greatest source of power for agriculturists in India and they had to remember that power could not be produced out of nothing. The problem of milk supply was also one which required their immediate attention. In most villages milk could be got only in very small quantities by the children and sometimes not at all.

Nitrogen Fixation in Soils.—Referring to the need for a scientific study of soils, Sir John said that they had not yet fully understood the remarkable cycle in Nature with reference to nitrogen production. Though that subject had been fairly fully studied in connection with the temperate climates, yet in the tropics it still remained to be studied adequately. Particularly, with reference to soil study, they had to conduct large-scale field experiments to ascertain facts and to work out processes. Some work in that direction had been done in U. S. A. But the results obtained there did not agree with those obtained in temperate climates, such as in England. In England they had established that the source of nitrogen in the soil was leguminous plants. But in the arid regions of U. S. A., they failed to get clear evidence of fixation by leguminous plants. What they should know was whether or not, in a country like India, fixation by free living organisms played an important part as a source of nitrogen. That was a problem of fundamental importance in soil study. In England they could not determine whether nitrogen fixation proceeded independently of leguminous plants. That could only be done in a tropical climate. Even in regard to experiments connected with composts and farm manures they found that the results varied as between England and America. Therefore if they wanted to obtain satisfactory solutions for their problems connected with agriculture, biochemists in India would have to solve them.

Water-logged Soils.—The chemistry of water-logged fields was another direction in which experimental work by biochemists would prove of great value to the Indian ryot. The conditions relating to water-logged areas in India differed very much from those in England, where water-logged areas were merely swamps where the water was stagnant. On the other hand, in India the water was being constantly renewed in water-logged areas owing to evaporation and replacement by fresh water. At present not enough was known about the micro-biological conditions of paddy soils. Sir John felt sure that there was great scope for the application of modern biochemical knowledge towards the improvement of paddy cultivation, especially by way of extension of the pioneering work carried out by Harrison and Iyer in that direction.

Utilisation of Wastes.—The use of waste products was another direction in which the biochemist could help a great deal. The possibilities of utilising on a commercial scale, plants and plant products which were not edible deserved study.

The biochemist could also contribute a great deal by studying problems connected with the utilisation of sewage. Sir John was glad to note that Dr. Gilbert Fowler, who had done a great deal of successful work in that direction, was present at the meeting. In the West as in England they had succeeded in disposing of the sewage in a healthy manner, though in a wasteful way. Dr. Fowler's method, however, enabled the Western method of sewage disposal to be adopted without losing the manurial value, especially in regard to nitrogen and phosphates. Phosphates formed an important fertilizer material whose supplies were almost monopolised by France and America. Thanks to the activated sludge method it had become possible to recover a considerable portion of the phosphates from sewage. The only problem in that connection which remained to be solved was that of drying the truculent colloids. The retention of moisture by colloids was a problem for the man of physics to solve.

Concluding, Sir John referred to the rapid growth of the sugar industry in India and the possibility of putting the by-product, *viz.*, molasses, to much better use than was being done now.

Physics in Hungary—Past and Present*—I.

By R. Ortvay, *Budapest*.

Introduction.

HUNGARY is a small country in a part of Europe where Western civilization meets East-European civilization developed under Byzantine influence and which was sometimes reached by the waves from the East. The Hungarians are an Eastern people, they came here from the East a thousand years ago, but their civilization is rather Western than East-European. In an unquiet part of Europe, at times defending itself and Europe against the East, at times fighting for its independence with the West, it has survived for 1,000 years and, suffering at present but not crushed, it is still hoping for a better future. Twice it was almost swept away from the earth. First, in the thirteenth century it was overrun by the Mongols and was almost ruined; then again in the sixteenth and seventeenth centuries, for 180 years, the greatest part of the country was occupied by the Turks. In the course of history Hungary had difficult fights with Austria to which it was joined by the person of the same ruler. Hardly had its relation with Austria improved, when the territory of the country was reduced to one-third of its former size after the Great War, and it was almost numbed in its national existence. But people believe with unaltered hope in the justice of Providence that things may change one day. It is quite natural that in such circumstances Hungary does not belong to the leading nations of European civilization and it does not occupy the place that the little nations in the West do in more favourable circumstances. Nevertheless Hungary always does her best to take part in any intellectual movement in Europe, contributing largely to the advance of European culture.

You have also had the opportunity to meet some representatives of Hungarian science; a scholar whose name is certainly familiar to many in India, A. Körösi-Csoma, was the first to compile a vocabulary of the Tibetan language; his tomb is still in Darjeeling.

You know the name of Sir Aurelius Stein, a Hungarian by birth who lives in India when not away on an expedition to fathom the secrets of Asiatic history.

I.

After this general introduction allow me to proceed to a discussion of certain moments of Hungarian physics of general import.

In the fifteenth century, in the reign of King Mathias Corvinus the fortress of Buda, now part of the capital city Budapest, was a splendid seat of Renaissance culture, the meeting place of foreign artists and scientists. Also the well-known astronomer John Regiomontanus had lived there for some years. But this promising beginning was soon swept away by the waves of the coming Turkish invasion. Later on in the reign of Queen Maria Theresa we find the Jesuit Max Hell one of the first to observe the solar transit of Venus. At the end of the eighteenth century and in the beginning of the nineteenth century lived the two Bolyais, father and son. It is well known that the younger of them John Bolyai was one of the first mathematicians, who independently of others invented a non-Euclidean geometry without any inner contradiction. I cannot go into details concerning the later development of Hungarian mathematics. I only wish to mention that John Segner, the inventor of the well-known rotating wheel, was also born in Hungary.

A pioneer of Hungarian physics, an interesting and original thinker was A. Jedlik, a Benedictine friar, Professor in the University of Budapest. He was the type of the unselfish, humble scientist who liked science for itself and did not want to bring it in connection with practical life. He made optical gratings with his self-made dividing machine, and constructed long before Siemens, an electric machine based on the dynamo principle. But Siemens perceived immediately the fundamental importance of this principle, on which an immense industry was built; Jedlik, on the other hand, never thought of a practical application and only cared for the working of his machines.

Now I shall pass on to a more modern and more powerful personality, Baron R. Eötvös, the most prominent representative of Hungarian physics. He came of a noble, historical family; his father was one of the most prominent and celebrated writers and politicians of the liberal era. He studied at German universities, was much influenced by Kirchhoff and was always more inclined towards phenomenalism than towards the corpuscular theory the popularity of which was rapidly growing in his time; he could appreciate, however, the final success of the latter.

Among his many-sided theoretical and experimental investigations in physics I shall only confine myself to his researches in gravity and capillarity.

A great part of his investigations in gravity is concerned with the change of the force of gravity on the surface of the earth and gives a method to determine this local variation which is the second derivative of the potential of gravity.

In other words his method makes it possible to determine the equipotential lines of gravity.

His method is based on a modification of the torsion-balance of Cavendish: a horizontal rod is suspended in the middle by an elastic wire and bears on both ends weights of equal masses. One of the two weights is joined closely to one end of the rod, the other hangs on a wire fixed at the other end. If the field of gravity is different in direction and intensity in the places of the two weights the equilibrium of the balance cannot result only from gravity, the balance will turn till the moment arising from the torsion of the wire makes a new equilibrium. The theory of the method shows that if we observe this elastic moment in six positions differing by angles of 60 degrees, we can obtain the six second derivatives of the potential. The idea of the method is very simple, but Eötvös had to overcome extraordinary difficulties in

* From a lecture delivered at the Indian Institute of Science, Bangalore, on 5th January 1937.

order to make his instrument function not only in his laboratory, but also in the open air. He was not only obliged to find out the quality of the elastic suspension wire, but he was obliged to eliminate some other disturbing circumstances, especially thermal air currents, arising from the unequal temperatures of the different parts of the instrument. He could not evacuate his instrument because the air was needed to damp the vibrations. Therefore he put the balance in a three-fold metal box and regulated the air current in such a way, that then the instrument met every demand. After perfecting his method Eötvös with the help of some prominent pupils measured large areas and determined the change of gravity and the connection between the anomalies of gravity and the geological structure. It is of very great practical consequence that the method of Eötvös makes it possible to determine the geological anticlinals and salt-domes which are often connected with oil. Such researches were made in Europe as well as in America and also in India by the order of the Burma Oil Company. Three expeditions were made in the winters of 1923-24, 1924-25, 1925-26 to Upper Indus, Upper Assam and in the State of Khairpur under the direction of D. Pekár, who as the Head of the Eötvös Geophysical Institute directed these researches with the help of many others after the death of R. Eötvös.

Another prominent pupil of Eötvös, S. Rybár, had put the Eötvös balance in a more handy shape and provided it with automatic photographic registering apparatus which saves much time and work. Because Eötvös did not apply for a patent for his instrument. other firms sell similar instruments; to-day they are indispensable for geophysical research.

Eötvös went with his balance into other questions of great theoretical importance. He investigated the question whether gravity is absorbed by matter. At sunrise or sunset there is a position for the balance in which the gravity of the sun is acting through the air upon the upper load. but through several miles of the earth upon the lower one. In spite of the sensibility of this method no absorption was to be observed.

The researches concerning the proportionality of the gravitational and inert masses are of greater importance. With the help of pendulums made of different materials, Newton proved that such proportionality existed within the limit of 1/1000. Later Bessel reduced this limit to 1/60,000 but nobody made such exact measurements as Eötvös and his pupils. Eötvös, Pekár and Fekete in their excellent work which won the first Beneke-prize of the University of Göttingen reduced the limit to 1/20,000,000; lately another pupil of Eötvös, John Ramer, showed that it was not greater than 1/2,000,000,000. The principal importance of these investigations is, that the gravitational theory of Einstein is based on the same proportionality of the gravitational and inert masses, and this is undoubtedly one of the fundamental laws of nature.

I cannot deal extensively with the investigations of Eötvös on terrestrial magnetism, but I cannot fail to mention his researches on capillarity.

First, he introduced a new method to determine the constant of capillarity. This method is independent of all suppositions concerning the angle between the surface of the liquid and the wall of glass. It may be applied to liquids in sealed glass-bottles at all temperatures up to the boiling point or to the critical-temperature. He ascertained the following law to be valid for liquids which do not dissociate at their boiling point. If α be the constant of capillarity. v the molecular volume, τ the absolute temperature, then:

$$\frac{\alpha}{\alpha\tau}(\alpha v^{2/3}) = 0{,}22\ \mathrm{F}\ (0{\cdot}227)/$$

or, integrated,

$$\alpha\, v^{2/3} = \mathrm{K}\ (\tau' - \tau)$$

τ' is that characteristic temperature of the liquid at which α disappears. Later Madelung and especially Born and Courant undertook theoretical investigations concerning the law of Eötvös and they found that the quantity K in conformity with experience is but minutely inconstant and may be expressed by the following formula:

$$\mathrm{K} = 0{,}210\ \left(1 + \frac{\theta}{3\tau}\right)$$

where θ is the critical temperature occurring in Debye's theory of solids.

I may say that Eötvös influenced the scientific life of Hungary most effectively not only with his important discoveries but also with his noble personality.

The greatest interest in the field of physical science in Hungary was taken in optics. First I have to mention I. Fröhlich who, with the result of the strenuous work of forty years, laid down the real foundation of Hungarian optical research. His investigations deal especially with the polarisation of diffracted light. He published his researches in a book written in German. He succeeded in proving with absolute certainty the penetration of light into the optically lighter material in the case of total reflexion. In connection with these investigations we have to mention the researches of P. Selényi, and the investigations on fluorescence of I. Fröhlich.

I. Fröhlich constructed further an instrument for measuring the intensity of an electric current on the basis of the electrodynamometer principle, and made also careful investigations to estimate the absolute electric resistance.

S. Rybár whose gravitational balance I have already mentioned, got a good result demonstrating the absolute value of the alteration in the phase of light in the case of total reflexion.

S. Rybár investigated further the Zeeman effect of Lanthanum and Cobalt, he also made valuable researches about the alteration of the constant of capillarity with temperature till the critical point of some liquids and found it in agreement with the formula of Eötvös.

The optical researches of B. Pogány deserve special attention with regard to the theory of relativity; he carefully repeated the Saquæ experiment at Zeiss's in Jéna. He established a big physical laboratory at the Technical University in Budapest. Here many band-spectra researches are conducted under the guidance

of R. Schmid with the assistance of many others. Many researches came out from that splendidly equipped Institute: *e.g.*, The correct separation of several bands, the determination of their Zeeman-effect, the energy of linkage in some carbonates, etc. There is an interesting instrument, an electromagnet with wedge-shaped poles of the length of 60 cm.: with its help it was possible to determine the Zeeman-effect of slightly absorbing materials, such as oxygen (O_2).

One of the most prominent pupils of Eötvös, who also works on gravity and capillarity, Ch. Tangl, has carried out important investigations concerning the dielectric constant. He investigated the change of the dielectric constant of gases resulting from the change of temperature and pressure. The writer of these pages investigated also the change of the dielectric constant of some liquids put under great pressure. Szalay investigated the change of the D. C. with regard to the dipole-theory of Debye.

In the last few years in Prof. Tangl's Institute in connection with the investigations of Miss Forró about the cosmical radiation a grand experimental arrangement was made. Later Barnóthy perfected the method. Now the device registers automatically the number of electrons which pass through both counters at an interval less than 10^{-5} second, but does not register electrons reaching the different counters at a longer interval. They went into the study of the question whether there is any periodicity about cosmic rays; last summer they explored the absorption of cosmic rays in the coal-mines at Dorog (Hungary) and found that the depth of 1,400 meters of water-equivalent was the noticeable limit of the penetration of cosmical rays.

Among other investigations I may mention the researches of Z. Gyulai about the photoelectric effect of selenium and salt and about their electrical conduction under the influence of light and his investigations about the process of crystallisation; Náray-Szabó determined the structure of some crystals by the method of Bragg; Szalay studied the dielectric constant and the ultrasonics. I call special attention to the investigations of G. Békéssy about the mechanism of hearing and some other problems of acoustics of technical importance, which are highly appreciated.

Everywhere in the world, the laboratories of the big factories are of growing importance not only for technical, but also for proper physical research. Also in the laboratories of the "Egyesült Izzólámpagyár" and "Vatea," two well-known factories for electric bulbs and radio valves, some important researches of purely scientific character are being made. Z. Bay, Director of the Research Laboratory of E. I., former Professor at the University of Szeged, analysed the electric discharge in rarefied gases and now he deals with the destruction of the nucleus. P. Selényi worked out a method for electrostatical registration.

In the laboratories of the "Vatea" factory Director Patay with the help of some others investigates high-emitting hot cathodes and physical problems connected therewith.

Theoretical physics has been of great interest since a long time in Hungary; first have been dealt with mechanics (Réthy, Konig), technical mechanics (K. Szily jr., Rejtö), and then the problem of the mechanical interpretation of the second law of thermodynamics (Réthy, K. Szily sr.).

A prominent personality in theoretical physics was T. Farkas. A scientist of strong mathematical mentality he was mainly concerned with the problems of mechanics, thermodynamics and electrodynamics. He was a very consistent representative of phenomenologism which is strongly connected with the names of Kirchhoff, Dham and Voigt. His best result was the interpretation of the principle of virtual displacement in the form characterised by Fourier by means of an inequality. He very carefully investigated the importance and the limit of validity of the principle and applied it to some problems in mechanics and thermodynamics. Dealing with the mathematical bases of the principle he was obliged to investigate the theory of linear inequalities and doing so he discovered the chief theorems of it independently though at the same time as Minkowski.

His investigations concerning thermodynamical equilibrium are of great importance, he expressed the second law of thermodynamics in a general formula, which is nearly the same as the celebrated formula given by Caratheodory fourteen years later.

Besides, Farkas dealt with pure mathematical problems too: with the principle of Huygens, he gave a continuum theory of electricity and was one of the first who appreciated the significance of the theory of relativity of Einstein.

In theoretical as in experimental physics some good investigations were made by V. Zemplén. He has done important researches to determine the internal friction of gases with the help of pendulating and rotating globes, and carried out investigations about some theoretical questions in mechanics, kinetic theory of gases and hydrodynamics.

Another student of theoretical physics E. Bródy worked for a long time with M. Born, together with whom he published several papers. I want to mention his work concerning the quantification of oscillations with finite amplitude and his researches about the chemical constant, band spectra, especially that of the NO molecule, and finally his investigations concerning the linkage of carbon atoms.

E. Császár dealt with the radiation of a black body and with other problems of quantum theory and recently with the absorption of X-rays.

K. Széll dealt with the entropy of gases in different cases.

(*To be continued.*)

RESEARCH ITEMS.

On a Characteristic Property of Trigonometrical Polynomials.—Markoff (*Comp. Math.*, **3,** Fasc. 3, 305-309) has proved the following theorem about periodic continuous functions. Let $f(x)$ be a function with period 1 (and continuous). Then only the following two cases are possible: either the sum $\sum_{k=1}^{n} f(k\alpha)$ considered as a function of n is bounded for every irrational α, or the set of values of α for which the sum is bounded form a set of the first catagory; and if the first case is ture, then

$$f(x) = \sum_{-N}^{N} a_k e^{2\pi kix} \text{ with } a_0 = 0$$

and in the second case no such representation is possible. The proof is elementary and is brought about by a series of lemmas of which the following are the leading ones:

Lemma 1. If under the same conditions as above $\left|\sum_{k=1}^{n} f(k\alpha)\right| \leqslant C$ for some irrational α, then $\left|\sum_{k=1}^{n} e^{2\pi mki\alpha} \int_0^1 f(x)\, e^{-2\pi mix}\, dx\right| \leqslant 2C$ and $\int_0^1 f(x)\, dx = 0$. (The latter part follows when we observe that $k\alpha - [k\alpha]$ is uniformly distributed in 0, 1.)

Lemma 2. Under the same conditions

$$\left|\frac{1}{1 - e^{-2\pi mi\alpha}} \int_0^1 f(x) e^{-2\pi mix}\, dx\right| \leqslant 2C$$

and

Lemma 3. If under the same hypothesis $\int_0^1 f(x)\, e^{-2\pi kix}\, dx \neq 0$ for an ∞ of k's, then the set of values of α for which the sum is bounded is of the first category. With the proofs of these three lemmas the theorem follows.

K. V. I.

Development of the Male Gametes in Angiosperms.—Poddubnaja-Arnoldi (*Planta*, 1936, **25**, 502-529) studied the development of the male gametes in some angiosperms with a view to find an answer to the following questions: (*a*) whether the male gametes are merely naked nuclei or cells, (*b*) whether the vegetative nucleus persists or undergoes an early degeneration (thus being of importance for the growth of the pollen tube or not) and (*c*) whether the nuclei in the tube have an independent movement of their own, or are merely carried passively by the streaming of the vegetative plasm? These questions are of considerable importance and it is, therefore, necessary to consider Mrs. Poddubnaja-Arnoldi's conclusions rather critically.

She describes sperm *nuclei* (and for most of these species also a naked generative nucleus) in *Cannabis sativa* L., *Aconitum lycoctonum* L., *Papaver somniferum* L., *Crepis capillaris* (L.) Wallr., *Taraxacum koh-saghyz* Rod., *Allium cepa* L., and *Secale cereale* L. No mention is made of the investigations of Golinski (1893) and Osterwalder (1898), who, contrary to her own observations) had seen sperm *cells* in *Secale cereale* and *Aconitum napellus*! She herself admits, however, that it is very difficult to obtain a good fixation for the male gametophyte and the reviewer can say from his own experience that the aceto-carmine method, which she preferred to use for the most part, may have led her to erroneous conclusions.

The same thing must be said with regard to her statement about the degeneration of the vegetative nucleus. It must be emphasised that only the Feulgen reaction can enable definite conclusions on the question whether the vegetative nucleus has degenerated or is still present. It may be admitted, however, that the vegetative nucleus does not now appear to be so extremely necessary for a normal germination of the pollen grains, as was thought before. As to its movement the author supposes that it is a passive one.

Generative and sperm cells are described in two species, *Pisum sativum* L., and *Nicotiana rustica* L. Pollen of these species as well as of *Secale cereale* was treated with X-rays (1000–80,000 " *r* "). At lower radiation forces the generative nuclei divide irregularly and form " Mikrospermien " or take a bicuit-like shape. At higher radiation forces the division does not take place at all and the generative nucleus shows a homogeneous or otherwise changed structure. Due to their incapability for division the author concludes that the generative nuclei are killed in these cases. The protoplasm, however, seemed to have remained unaffected by the radiation, since the tubes were still growing quite normally. Though killed by the radiation (if we are to accept the opinion of the author), the generative cells of *Pisum* and *Nicotiana* and the sperm cells (Golinski :) of *Secale* were able to enter the pollen tube. From this it is inferred that the male gametes have no independent power of movement but are carried along passively.

To this conclusion must be raised the following objections: (1) the author only showed that the generative nuclei do not divide after radiation and not that they were necessarily dead, and that (2) an active movement of the generative cell would really depend far more on the activity of its plasm than of the nucleus within it. The author herself shows that the vegetative plasm behaves quite normally after radiation and it would seem reasonable to conclude that the same is the case with the generative plasm. Just for that reason alone, it would seem possible that the generative cells continue to move independently in spite of the changed (not killed !) nuclei. Even if we were to admit that the generative or sperm nuclei are naked, the possibility of their being able to move independently cannot be denied, for the author only proved

their incapability to divide; it does not necessarily follow that they also lost their power of movement and had to be carried by the streaming of the vegetative plasm!

H. D. WULFF.

The Influence of Moonlight on the Activity of Certain Nocturnal Insects, particularly of the Family Noctuidae, as indicated by a Light Trap.—Since he came over to Rothamstead from Edinburgh in 1932, Dr. Williams has been chiefly engaged in studying insect activity in relation to climatic and weather conditions. His method of insect collection has been by means of a light trap, redescribed by him recently in its improved form (*Trans. Roy. Ent. Soc.*, 1935) its chief feature being a clock-work arrangement by which the time of entry of an insect into the trap can be estimated. The captures made by this trap were used to test the popular belief that insect activity, at least in certain groups, particularly Lepidoptera, decreases on moon-lit nights, this decrease being especially noticeable in those insects that are attracted to light. (Williams, *Phil. Trans. Roy. Soc., Lond.*, (B), October 1936.)

For this purpose moonlight was measured by a photographic instrument which produced a line image of the moon by means of a cylindrical lens focussed on to a strip of a sensitive paper. As moonlight is considerably affected by the presence of clouds in the sky this factor was also measured by means of a long focus camera which photographed the pole star and the tracings of its image on a sensitive paper gave a measure of cloudiness each night.

Dr. Williams' finding is that there is a distinct lunar effect on insect captures at night; fewer insects coming to the trap on moon-lit nights than on dark ones. Whether this is due to the fact that a moon-lit night being a clear night is cooler and not many insects are flying about owing to this fall in temperature or that the moonlight is competing with the artificial light of the trap and reducing its efficiency is a point that is not definitely answered in the paper. Dr. Williams inclines to the view that the effect of moonlight is at least partly physiological since it differs in different groups of insects without any reference to their time of flight but promises to settle the point by further work, using a method of insect collection which has not to depend on light as an attraction. Incidentally this will also widen the range of the investigation by making it possible to study the reactions of certain other insects that are not positively phototropic.

K. B. LAL.

Chromosomes of Ant-lions.—In a paper entitled "The chromosomes of six species of Ant-lions (Neuroptera)" published as contribution No. 106, November 1936, from the Zoological Institute, Faculty of Science, Hokkaido Imperial University, Japan, J. J. Asana and Hisao Kichijo have recorded their investigations on the chromosomes of six species of Neuroptera from India.

Our knowledge of the chromosomes of this interesting group of insects is of very recent growth. In the year 1932 Oguma and Asana[1] published a report on the chromosomes on an Indian species of Palpares. Since then considerable advance has been made by other investigators among whom the work of Naville et de Beaumont[2] has thrown much light on the establishment of systematic relationship of the chromosomes between allied orders. So far as the literature shows, the chromosomes of Neuroptera have been investigated in 33 species covering eight families. All the authors are in agreement that in the species they have studied the male is heterogametic, the male sex cells are of the usual two types, the X- and Y-bearing complexes. Again, the two components of X–Y complex among all these species show a striking uniformity in their behaviour at the time of reduction division. They show a remarkably precocious separation in contrast to the behaviour of the autosoma tetrads at this stage of spermatogenesis in Neuroptera.

The numerical relation between the chromosomes of six species of ant-lions from India is given in the following table:—

Species	Haploid	Diploid	Sex-chrom
(*a*) Myrmeleonidæ—			
1. Myrmecælurus sp. (*M. acerbus*?) ..	7	14	XY
2. Macronemurus sp.?	8	16	XY
3. Neuroleon sp.	8	16	XY
4. Myrmeleon sp. (*M. sagax*?) ..	7	14	XY
(*b*) Ascalaphidæ—			
5. *Ogcogastor segmentator* ..	..	22	XY
6. *Glyptobasis dentifera* ..	..	22	XY

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[1] Oguma, K., and Asana, J. J., *Journ. Fac. Sci. Hokkaido Imp. Univ.*, 1932, Ser. VI, 1.

[2] Naville, A., et de Beaumont, *Arch. d'Anat. Microsc.*, T. 29.

SCIENCE NOTES.

Indian Physical Society.—The Third Annual Meeting of the Indian Physical Society was held at Hyderabad (Deccan) on the 6th January, with Prof. M. N. Saha (President) in the Chair.

The President delivered an address on "Mission of Physicists in India" which was followed by a talk on Cosmic rays.

The following were duly elected office-bearers and members of the Council for 1937:—

President: Prof. M. N. Saha; *Vice-Presidents:* Dr. S. K. Banerjee, Prof. D. M. Bose, Prof. G. R. Paranjpe and Prof. H. P. Waran; *Secretary:* Prof. S. K. Mitra; *Treasurer:* Prof. P. N. Ghosh; *Members of the Council:* Prof. A. C. Banerjee, Prof. S. N. Bose, Dr. B. N. Chuckervatty, Prof. P. K. Datta, Prof. K. Prasad, Dr. K. R. Rao, Prof. B. B. Ray, Prof. N. C. Ray, Principal B. M. Sen, Prof. N. R. Sen, Prof. J. B. Seth and Prof. M. R. Siddiqui.

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Calcutta Mathematical Society.—At the Annual Meeting, held on the 31st January, the following were elected office-bearers and members of the Council for the year 1937:—

President: Professor Syamadas Mukherjee; *Vice-Presidents:* Principal B. M. Sen, The Hon'ble Sir S. M. Sulaiman, Professor C. V. Hanumantha Rao, Dr. N. N. Sen and Professor F. W. Levi; *Treasurer:* Mr. Satis Chandra Ghosh, *Secretary:* Mr. S. K. Chakravarty; *Other Members of the Council:* Professor N. C. Roy, Dr. S. M. Ganguly, Mr. Ramaprosad Mukherjee, Professor N. R. Sen, Professor A. C. Banerjee, Dr. P. L. Srivastava, Dr. M. R. Siddique, Professor N. M. Basu, Dr. C. N. Srinivasiengar, Dr. J. Ghosh, Dr. R. N. Sen and Dr. S. C. Dhar.

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Indian Chemical Society.—At the Thirteenth Annual General Meeting of the Society held on Wednesday, the 6th January, the following were elected office-bearers:—*President:* Prof. J. C. Ghosh; *Hon. Secretary:* Prof. B. C. Guha; *Hon. Treasurer:* Prof. P. Neogi; *Hon. Editors:* Dr. S. S. Joshi, Dr. A. C. Sircar; *Hon. Auditors:* Mr. P. C. Nandi and Mr. T. K. Roy Choudhuri.

The following resolutions of the Fine Chemicals Committee were passed:—"Resolved that a circular be issued by the Hon. Secretary of the Indian Chemical Society to Universities, Colleges and Research Institutes requesting them to send copies of their indents for organic and inorganic chemicals for the last three years with quantities and price."

"Resolved further that a Sub-Committee consisting of the following, with power to co-opt, be appointed to consider the replies received:—Prof. P. C. Mitter (*Convener*), Drs. M. S. Patel, B. C. Guha, H. K. Sen and K. H. Hassan."

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Society of Biological Chemists (India).—The Sixth Annual General Meeting of the Society was held on Wednesday, 6th January 1937, at Hyderabad. Lt.-Col. S. L. Bhatia presided. The Revised Rules were accepted with certain modifications.

The following office-bearers were elected for the year 1937:—

President: Dewan Bahadur Dr. Sir U. N. Brahmachari; *Vice-President:* Dr. Gilbert J. Fowler; *Hon. Secretaries:* Dr. C. N. Acharya, Mr. B. H. Iyer; *Hon. Treasurer:* Dr. V. Subrahmanyan; *Hon. Auditor:* Mr. M. Srinivasan; *Members of the Executive Committee:* Dr. V. N. Patwardhan, Dr. B. C. Guha, Dr. M. Damodaran, Dr. B. N. Iyengar, Mr. N. V. Joshi, Dr. P. E. Lander, Dr. N. R. Dhar, Dr. S. Kasinatha Ayyar, Mr. Y. D. Wad, Dr. H. K. Sen and Dr. T. N. Seth.

A joint meeting of the Physiological Society of India and the Society of Biological Chemists (India) was also held at the same time and place, to consider the desirability of starting an *All-India Journal of Physiology and Biochemistry*. The following resolutions, moved from the Chair, were unanimously accepted:—(1) This joint meeting considers that it is desirable to have a common journal for the Physiological Society of India, the Society of Biological Chemists (India) and the Biochemical Society of Calcutta. (2) A Committee consisting of the following gentlemen be authorised to go fully into all matters connected with the starting and running of such a Journal and to report their conclusions at the next Annual General Meeting of the Societies concerned to be held at Calcutta in January 1938:—Col. Bhatia (*Convener*), Dr. Burridge, Rao Bahadur B. Viswa Nath, Dr. V. Subrahmanyan, Dr. B. C. Guha, Dr. B. Narayana, Mr. Y. D. Wad, Dr. A. S. Paranjpe, Dr. Rahman, Dr. N. M. Basu, Dr. Basheer Ahmed and Dr. C. N. Acharya.

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Association of Economic Biologists.—The Seventh Annual Meeting of the Association of Economic Biologists, Coimbatore, was held on 1st February 1937. The following office-bearers were elected:—

President: Mr. K. Krishnamurthi Rao; *Vice-President:* Dr. J. S. Patel; *Secretary:* Mr. M. C. Cherian.

The retiring President, Mr. V. Ramanatha Ayyar, delivered an address on "Herbaceum Cottons of India".

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Indian Botanical Society.—At the Annual Meeting of the Indian Botanical Society held on Wednesday, the 6th January at Hyderabad, the following office-bearers were elected for 1937–1938:—

President: Dr. B. Sahni; *Vice-Presidents:* Dr. S. R. Bose and Mr. H. G. Champion; *Members of the Council:* Dr. S. P. Agharkar, Dr. Y. Bharadwaja, Mr. K. Biswas, Dr. H. Chaudhuri, Prof. R. H. Dastur, Dr. T. Ekambaram, Dr. S. L. Ghose, Dr. K. C. Mehta, Prof. J. H. Mitter and Prof. P. Parija.

A Sub-Committee consisting of the following botanists was formed to consider the suggestion by the International Commission on Agricultural Meteorology, for a scheme for recording phenological observation in India:—

Dr. S. P. Agharkar, Mr. H. G. Champion, Prof. A. C. Joshi, Prof. M. Sayeeduddin, Dr.

M. O. P. Iyengar, Prof. P. Parija, Dr. R. R. Stewart, Dr. K. Biswas, Dr. E. K. Janaki Ammal. Dr. C. D. Darlington, Cytologist, John Innes Horticultural Institution, Merton, England, was unanimously elected an Honorary Member of the Indian Botanical Society.

* * *

Index to Geological Literature Available in Bangalore.—The *Central College Geological Society* has just started the publication of a monthly Index to the geological literature available in Bangalore, the need for which has been increasingly felt within recent years by the increasing number of those engaged here in geological research. Between the Central College, Mysore Geological Department, and the Indian Institute of Science, nearly 30 journals and periodicals relating to Geology are received, and the proposed Index is a compilation wherein all the papers appearing in these journals will be properly classified in a form suitable for readers' reference. The number for January 1937 which has just been issued, speaks for itself about the value and usefulness of such a compilation.

* * *

Measurement of the Non-skid Properties of Road Surfaces.—(His Majesty's Stationery Office. Price 9*d.*) The provision and maintenance of non-skid road surfaces is a matter of vital concern to road users and has received great attention in the past few years from road makers. A means of measuring the slipperiness of a road surface is provided by the motor-cycle and sidecar apparatus, which has been in regular use for a number of years. The apparatus and its method of operation are described in Road Research Bulletin No. 1.

* * *

Studies in Road Friction—1. Road Surface Resistance to Skidding.—(His Majesty's Stationery Office. Price 1*s.* 6*d.*)—The results and conclusions drawn from the large number of tests made with the above apparatus are given in Road Research Technical Paper No. 1.

* * *

The National Academy of Sciences (U.P.).—We have pleasure in congratulating Prof. B. Sahni, D.SC., SC.D., F.A.S.B., F.G.S., F.R.S., Head of the Department of Botany, University of Lucknow, on his recent election as President of the National Academy of Sciences. Prof. Sahni's eminence in the scientific world is a source of pride to all who know him and his achievements have raised the prestige of this country as a competitor in producing new knowledge. We have no doubt that under his inspiring guidance, the National Academy of Sciences, which already occupies an important position and fulfils a great purpose, will add fresh lustre to its distinguished record.

* * *

Dr. K. S. Krishnan, Mahendralal Sircar Professor of Physics at the Indian Association for the Cultivation of Science, is proceeding to England shortly. He has been invited to deliver a course of lectures on the physics of crystals at Cambridge and other Universities in England and on the Continent.

Much of Professor Krishnan's earlier work was carried out at the Indian Association for the Cultivation of Science in collaboration with Prof. Sir C. V. Raman, F.R.S., N.L. During the last few years Prof. Krishnan has carried out valuable researches on the magnetic properties of crystals, and has contributed a series of memoirs on this subject which have been published in the *Transactions of the Royal Society*. He was invited to attend the International Conference on Photoluminiscence held at Warsaw a few months ago.

Professor Krishnan's recent work relates to the study of properties of crystals in the neighbourhood of absolute zero temperature.

* * *

Professor Bailey Willis in Bangalore.—Professor Bailey Willis, Emeritus Professor of Geology, Stanford University, California, U.S.A., who is on a world tour paid a short visit to Bangalore during the latter half of January. *The Central College Geological Society* took advantage of his brief stay here and invited him for a social evening and to address the members. Professor Willis is a great traveller, a geologist of international reputation, and author of numerous papers on tectonics and general geology.

After a group photograph and tea, an assembly was held. The distinguished guest was introduced by Prof. L. Rama Rao. Professor Willis then addressed the meeting on "The Crust of the Earth". The Lecturer said that it was no longer possible to believe that the crust was a thin hard layer which was formed by the cooling of a molten globe. Recent evidences show that the earth is solid and rigid practically to the core. The key to this problem was to be found in radioactivity. Radioactive elements were not distributed uniformly but sporadically in the interior of the earth, and by their disintegration enough heat was produced in certain localities to cause melting of the rocks. Differentiation took place in these rock magmas which were extruded at various periods in the history of the earth and gave rise to the crust. After the lecture, several members asked him questions to which he gave suitable replies, drawing mostly from his wide experience of different lands, acquired during his travels.

* * *

Dewan Bahdur Dr. L. K. Ananthakrishna Iyer, B.A., M.D. Hon. (Bres.), one of the foremost anthropologists in India, whose work has brought him quite a large number of honours, has recently been elected an Honorary Member of the Scottish Anthropological Society, Edinburgh. We have pleasure in offering him our cordial felicitations. We wish him a long life of uninterrupted health and prosperity.

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Imperial Economic Committee: Vegetable Oils and Oilseeds.—The Imperial Economic Committee, in a statistical review of world production and trade entitled "*Vegetable Oils and Oilseeds*", points out that the consumption of fatty oils of vegetable origin has developed enormously with the increased demand for fats, although animal products, *i.e.*, butter, lard and tallow,

remain the principle individual fats of commerce. The seeds and nuts of many different plants and trees can be made to yield oil, the review deals with those of chief commercial importance.

According to a press note issued by the Director of Public Instruction, the British Empire, particularly in India and the Colonies, is an important producer of vegetable oils and oilseeds, and many parts of the Empire carry on a considerable export trade. On balance, the Empire has a substantial net export for many of the oilseeds and nuts, notably groundnuts, palm kernels and copra. There is, however, a large net import into the Empire of cottonseed, linseed and soya beans.

Cottonseed.—Cottonseed is an important source of income to the cotton farmer. Almost the entire output in the United States, which is by far the largest producer, is consumed at home and exports from India, the second largest producer, have been negligible in recent years. Egypt, the Anglo-Egyptian Sudan and Uganda are the principal exporters of cottonseed, while there are only two large importers, the United Kingdom and Japan.

Linseed.—Argentina, the largest producer of linseed accounts for over four-fifths of the world exports. India and Uruguay are next in importance. Imports into the United Kingdom come almost entirely from Argentina and India and since 1933 the latter has been the chief supplier except in 1935.

Groundnuts.—India and China are the principal producers of groundnuts, but both retain a large part of their production. Senegal, Nigeria and the Gambia, on the other hand, export the greater part of their output. France, the first European country to import groundnuts, still maintains its place as the leading importer.

Copra.—The largest exporters of copra are the Netherlands, East Indies and the Philippines, the latter also shipping large quantities of cocoanut oil. Exports from Empire countries amount to roughly one-third of the world total. British Malaya and Ceylon are the chief Empire exporters, but the trade is of the greatest importance to Fiji, accounting for about 13 per cent. of the value of all domestic exports between 1931 and 1935. Imports into the United Kingdom, which have tended to increase, are now shipped entirely from the Empire.

* * *

Survey of India.—During the year 1936, for which the report has just been published, the Survey of India completed the survey of 57,036 square miles, of which 3,987 square miles were areas previously surveyed in the more thickly populated districts and now brought up to date. Original survey was completed in 53,049 square miles on various scales, thus completing for India a total of 1,304,453 square miles of modern survey, leaving 580,187 square miles yet to be surveyed (according to a press note issued by the Director of Public Information, 2nd February 1937).

The methods used were mainly triangulation or traverse frame work, with the details filled in by plane table, or in some cases surveys from air photographs.

Various large-scale city and cantonment surveys were also carried out, the most notable amongst which was the combined air and ground survey of Nagpur in the Central Provinces.

Though the primary duties of the Survey of India are geodetic, topographical and geographical, the Department is also developing cooperation with local survey agencies with a view to mutual economy and is now doing a considerable amount of miscellaneous outside work on payment, besides advising and assisting the Provincial Governments with local and settlement surveys as required.

A special party, it may be mentioned, was formed in October 1935, to assist the Sino-Burmese Boundary Commission.

The work of the Department during 1936 has not been without adventure. A party penetrated the " Inner Sanctuary " of Nanda Devi, of which they made a photographic survey under very arduous conditions. A surveyor and his party were almost overwhelmed by a severe snow-storm in the upper reaches of the Gangotri Glacier in Tehri-Garhwal, and narrowly escaped with their lives. Surveyors accompanied the Visser Expedition to the Karokoram in 1935 which returned to India shortly after the opening of the present survey year, with satisfactory results, and a surveyor is still with Sir Aurel Stein on his archæological expedition to Iran. And it goes without saying that in portions of the area under regular survey, elephants, tigers and panthers were numerous and gave the alarmed surveyors some uneasy moments.

* * *

The Pasteur Institute, Coonoor.—The annual report of the Institute for the year ending 31st December 1935 shows that during the year covered by the report there were no deaths from hydrophobia among those treated at the Institute. This is the third time in the history of the Institute that no death has been reported. 433 patients underwent full treatment and 102, incomplete treatment during the year. The Paris Fixed Virus was in use throughout the year for the preparation of the vaccine and was in its 958th passage at the close of the year. 14,084 courses of antirabic vaccine were issued to the out-centres and the several centres returned 12,282 case cards as completely treated and 2,248 cards as incompletely treated. The total number of deaths from hydrophobia was 20, giving a mortality rate of 0.16 per cent. A total of 12,05,320 c.c. of the antirabic vaccine was prepared during the year. 10 research papers dealing mainly with the studies pertaining to the nutrition of Indian foodstuffs, were published during the year under review.

* * *

The Institute of Brewing.—To celebrate the Silver Jubilee of the foundation of the *Laboratory Club*, which developed into the *Institute of Brewing*, the Council of the Institute decided to issue in November 1936, a Special Number of the Journal of the Institute of Brewing " Containing memoirs by eminent and experienced men, on the progress made in the malting and brewing during the last five decades". As far back as 1876, a group of enthusiasts, among whom may be mentioned

Cornelius O'Sullivan, Adrian Brown and others, inaugurated an informal dining club, the "Bacterium Club" to meet to discuss new discoveries in bacteriology and chemistry relevant to brewing. As the importance of chemical and biological aspects of malting came to be increasingly realised, and the need for the control and analysis of materials and products became compelling, chemists who had a knowledge of brewing started classes in their laboratories to provide instruction on the principles of brewing. Dr. E. R. Moritz, a prominent chemist of the time, realising the importance of discussions and exchange of information and experience between those having aims in common founded in 1886 the *Laboratory Club*. The papers read at the meeting of the Club were recorded in the *Transactions of the Laboratory Club*, the forerunner of the *Journal of the Institute of Brewing*, which is a systematic and continuous record of the labours of numerous investigators interested in the science and practice of brewing. Dr. A. R. Ling was the first editor of the journal.

The Special Number contains nine memoirs covering 54 pages, includes such subjects as, 'Advances made during the last 50 years in malting,' by H. M. Lancaster; 'Advances in the knowledge of malt conversion during the last 50 years,' by Prof. Arthur R. Ling; 'Development of our knowledge of the chemistry of alcoholic fermentation during the last 50 years,' by Sir Arthur Harden; 'Progress in brewery Fermentation during the last 50 years,' by Lloyd Hind; 'Advances made in Brewing, the dietetic value of beer and the by-products of brewing during the last 50 years,' by R. H. Hopkins. The Jubilee Number will be warmly welcomed by all those interested in the progress of fermentation research.

* * *

Research and Progress.—The first number of the Third Volume of this Journal has recently been received. Up to the present, the *Review* was being published as a quarterly. As the Editors have found it difficult to keep up a sufficiently topical commentary on German scientific progress, they have decided to issue it as a two-monthly, hereafter. The price of the single copy will be R.M. 1.50: postage extra. The annual subscription, for the six issues, is R.M. 6.

All enquiries regarding the Journal may be made to the Editorial Office, Unter den Linden 8, Berlin N.W. 7.

* * *

In a previous number of this Journal a short account of the National Geographic Society-Smithsonian Institution **East Indies Expedition**, was published. (Jan. 1937, page 403.) It is now understood that Dr. Mann who leads the expedition, plans to collect, not only rare species of animals and reptiles from the island of Sumatra and other far-away corners of the East for the National Zoological Park in Washington, but he will take with him American animals, which, though common in zoos of that country, are little known in the Far East. It is, perhaps, the first time that an animal-collecting expedition ever started out from America with a good-sized menagerie "in its baggage".

Among Dr. Mann's animal globe-trotters will be oposums, raccoons, mountain lions, jaguars and possibly a black bear or two. Familiar to the eyes of American zoo-goers, these animals are as unusual in the Far East as tigers or aardvarks are in the United States.

Dr. Mann will present the American animals as gifts to zoos in various cities which he expects to visit on the Orient. The gifts will cause no depletion of American zoos, for there is a surplus of these animals in that country.

* * *

Announcements.

International Congress of Psychology.—Owing to conditions in Spain, the eleventh *International Congress of Psychology* which was to have been held in Madrid will be held in Paris. So far as possible, the programme will be the same as that previously arranged for the proposed meeting in Madrid. The Paris Congress will be held on July 25–31, under the presidency of Prof. Pierre Janet, formerly Professor of Psychology in the College de France. Further information can be obtained from M. Henri Pieron, Laboratoire de Psychologie de la Sorbonne, Paris 5. (*Nature*, 1937, January 2.)

* * *

International Congress on Testing Materials.—The next International Congress of the International Association for Testing Materials will be held in London on April 19–24, under the presidency of Sir William Bragg. More than two hundred papers are promised from authorities in twenty different countries. The Congress will be divided into the following groups: metals (behaviour of metals as dependent upon temperature, particularly in regard to high temperatures; progress of metallography; light metals and their alloys; wear and machinability); inorganic materials (concrete and reinforced concrete) erosion and corrosion of natural and artificial stone; ceramic materials); organic materials (textiles; wood cellulose; timber preservation, ageing of organic materials; colours and varnishes); subjects of general importance (relation between results of laboratory tests and behaviour in use and service; bearing of recent advances in physics and chemistry on the knowledge of materials; properties of materials for the thermal and acoustic insulation buildings).

Further information can be obtained from the Honorary Secretary of the Congress, K. Headlam-Morley, 28, Victoria Street, London, S.W.—(*Nature*, 1937, January 2.)

* * *

It is announced that the **International Congress of Genetics** which should have been held in Moscow, U.S.S.R., during 1937, has been postponed on the request of a number of scientists who desired more time for preparation for the Congress. The only purpose of this postponement is the desire to assure the best preparation and the most extensive participation of scientists from various countries.

* * *

We acknowledge with thanks receipt of the following:—

"Journal of Agricultural Research," Vol. 53, Nos. 7 and 8.

"Indian Journal of Agricultural Science," Vol. VI, Part VI, December 1936.

"Monthly Bulletin of Agricultural Science and Practice," Vol. 27, No. 11, November 1936.

"The Philippine Agriculturist," Vol. 25, No. 8.

"Journal of the Royal Society of Arts," Vol. LXXXIV, Nos. 4389–4391.

"Biochemical Journal," Vol. 30, No. 12, December 1936.

"Biological Reviews," Vol. 12, No. 1, January 1937.

"Communications from the Boyce Thomson Institute," Vol. 8, No. 4.

"Journal of the Institute of Brewing," Vol. XLIII, No. 1, January 1937, and Index to Vol. XLII.

"The Calcutta Review," Vol. 62, No. 1.

"Chemical Age," Vol. 35, No. 913, Vol. 36, Nos. 914–916.

"Journal of Chemical Physics," Vol. 5, No. 1, January 1937.

"Journal of the Indian Chemical Society," Vol. 13, No. 10, October 1936.

"Berichte der Deutschen Chemischen Gesellschaft," Vol. 69, No. 13; Vol. 70, No. 1.

"Russian Journal of General Chemistry," Vol. VI, Nos. 9–11.

"Journal de Chimie Physique," Vol. 33, No. 12.

"Experiment Station Record," Vol. 75, No. 6.

"Indian Forester," Vol. LXIII, No. 2.

"Forschungen und Fortschritte," Vol. 13, Nos. 1–3.

Government of India Publications:—

"Indian Trade Journal," Vol. CXXXIII, Nos. 1595–1597.

"Publications of the University of Illinois," Nos. 23, 24, 31 and 32.

Publications of the League of Nations—"Quarterly Bulletin of the Health Organization," Special Number and Vol. V, No. 4.

"Indian Journal of Medical Research," Vol. XXIV, No. 3, January 1937.

"The Calcutta Medical Journal," **32**, No. 1.

"The Punjab Irrigation Research Institute—Report for the year ending April 1936."

"The Pasteur Institute of Southern India—Annual Report of the Director for the year ending 31st December 1935."

"University of Cambridge, School of Agriculture, Memoirs" No. 8, 1936.

"Scientific Reports of the Imperial Council of Agricultural Research, Pusa," 1934–35.

"Journal of the American Museum of Natural History," Vol. 38, No. 5, December 1936.

"Nature," Vol. 138, No. 3504, Vol. 139, Nos. 3505–07.

"Journal of Nutrition," Vol. 12, No. 6, December 1936.

"Indian Journal of Physics and Proceedings of the Indian Association for the Cultivation of Science," Vol. X, Part VI.

"Canadian Journal of Research," **14**, No. 12.

"Ceylon Journal of Science," Section A, Botany, Vol. XII, Part II.

"Science and Culture," Vol. II, No. 8.

"Science Progress," Vol. XXI, No. 123.

"Indian Journal of Venereal Diseases," Vol. 2, No. 4, December 1936.

"Indian Journal of Veterinary Science and Animal Husbandry," Vol. VI, Part IV.

"Arkiv fur Zoologie," Vol. 28, No. 4, 1936.

Catalogues:

"Mitteilungen uber Neuerscheinungen und Fortsetzungen," 1937, No. 1 (Verlag von Gustav Fischer, Jena).

Cambridge University Press, Spring and Summer Books.

ACADEMIES AND SOCIETIES.

Indian Academy of Sciences:

January 1937. SECTION A.—I. CHOWLA: *On Waring's Problem for Cubes.* S. BHAGAVANTAM AND A. VEERABHADRA RAO: *Raman Spectrum of Benzene Vapour.*—The Raman Spectra of benzene in the liquid and vapour states have been photographed alongside each other under identical conditions. When judged by comparing with the 992 line, there is found a very considerable fall in the absolute intensity of the wings as we pass from the vapour to the liquid. B. R. SETH: *On the Flexure of a Hollow Shaft—II.* V. V. NARLIKAR: *A Note on the Mixed Tensor $T\mu^{\nu}$.* S. L. MALURKAR AND M. P. SRIVASTAVA: *On the Differential Equation of the Instability of a Thin Layer of Fluid Heated From Below.* S. CHOWLA: *A Theorem of Erdös.* I. CHOWLA: *On the Number of Solutions of Some Congruences in Two Variables.* L. A. RAMDAS, B. N. SREENIVASIAH AND P. K. RAMAN: *Variation in the Nocturnal Radiation from the Sky with Zenith Distance and with Time during the Night.*—The observations show that the nocturnal cooling of the radiating air layers as shown by the decrease in the equivalent black body temperature of the sky is maximum for the horizontal and minimum for altitude 90°. B. S. MADHAVA RAO: *On the Fine Structure of the Balmer Lines.*—If we lay aside the Born-Schrödinger Radius for the electron as untenable, we can conclude that the interaction of the electron and radiation field does not materially effect the energy levels. R. VAIDYANATHASWAMY: *A Remarkable Property of the Integers Mod N, and Its Bearing on Group-Theory.* R. ANANTHAKRISHNAN: *The Raman Spectra of Crystal Powders. I.—The Halides and Sulphate of Ammonium. II.—The Chlorides and Sulphates of Hydroxylamine and Hydrazine.*—A new technique has been developed using a pair of complementary filters. It is found that when the co-valency of nitrogen changes from three to four, there is a definite lowering of the N-H frequency, and therefore a weakening of the N-H bond. R. S. KRISHNAN: *Dispersion of Depolarisation of Light-Scattering in Colloids. Part I.—Gold Sols.*—In the region of the characteristic absorption the depolarisation factors show an enormous increase. By applying Gan's theory it is inferred that the particles in the gold sols behave optically like elongated ellipsoids with axial ratio equal to about 0.75,

January 1937. SECTION B.—G. N. RANGASWAMI AYYANGAR, M. A. SANKARA AYYAR AND V. PANDURANGA RAO: *Linkage between Purple Leaf-Sheath Colour and Juiciness of Stalk in Sorghum.*—In sorghum there is a linkage between the factor *P* for purple leaf-sheath colour and *D* for juiciness of stalk, with a recombination percentage of 30 ± 1.8. G. N. RANGASWAMI AYYANGAR, V. PANDURANGA RAO, A. KUNHIKORAN NAMBIAR AND B. W. X. PONNAIAH: *The Occurrence and Inheritance of Waxy Bloom on Sorghum.*—The heavy bloomed condition (H) is a simple dominant to the sparse bloomed condition (h). The factor (H) is independent in inheritance to the leaf-sheath colour factors P and Q, leaf margin disposition factor $M\mu$, grain surface structure factor Z, and the brown grain factors B_1 and B_2. S. C. DIXIT: *The Chlorophyceæ of the Bombay Presidency, India—I.* Thirty-six forms have been described, out of which four have been found growing in soil, three on stones and rocks, one on a gastropod shell, four in running water and the rest from the steady waters of pools, tanks and ponds. M. B. MIRZA AND M. A. BASIR: *A Report on the Guinea-Worm found in* Varanus *Sp., with a Short Note on* Dracunculus medinensis.—*Dracunculus* is recorded for the first time as a parasite of *Varanus*. The structure of the worm has been compared with that of *Dracunculus medinensis* and it is concluded that it is the same worm which parasitizes the human beings.

Indian Association for the Cultivation of Science: (*Proceedings, Vol. XIX, Part 6.*)

December 1936.—G. N. BHATTACHARYYA: *Studies on Some Indian Vegetable Oils.* JAI KISSEN AND N. K. SAHA: *On the Laws of Distribution of Velocities of Particles undergoing Emission and Absorption in Radiation-Field.* SURAIN SINGH SIDHU: *The L-Spectra of Iron above the Curie Point.* M. K. SEN: *The Band Spectrum of Gallium Oxide and Isotopes Effect of Gallium.* C. J. PHILLIPS: *The Raman Spectra and the Latent Heat of Fusion of Non-Associated Substances.* P. N. KALIA: *Technique of making Schumann-Plates; and A note on the Spectrum of Singly Ionised Zinc.* JAGANNATH GUPTA: *Raman Spectra of Oxalates and Oxalato-Complexes: Vibrations of Dicarbaxyl.* S. C. SIRKAR AND J. GUPTA: *On the Raman Spectra of Different Modifications of a few Crystals.*

Indian Chemical Society:

October 1936.—PRAFULLA KUMAR PAUL: *On Phthalide Formation.* N. R. DHAR AND CH. I. VARADANAM: *Preparation and Properties of Highly concentrated Sols. Part V.—Stannic Hydroxide Sols.* G. V. JADHAV, S. N. RAO AND N. W. HIRWE: *Derivatives of 1-Hydroxy-2-Naphthoic Acid. Part I.—4-Halogeno-1-Hydroxy-2-Naphthoic Acid and their Derivatives.* MAHADEO PRASAD GUPTA AND SIKHIBHUSHAN DUTT: *The Chemical Examination of* Solanum xanthocarpum, *Schard and Wendel. Part I.—The Constituents of the Oil from the Seeds.* DUHKHAHARAN CHAKRAVARTI AND BHOWANI CHARAN BANERJI: *Synthesis of Coumarins and Chromones from Halogenated and Nitrocresols.* B. N. GHOSH AND S. S. DE: *The Enzymes in Snake Venom. Part II.—Their Action on Native Proteins, on Peptone and on the Activity of Trypsin.* T. P. GHOSE AND S. KRISHNA: *Constituents of the Leaves of* Vitex negundo. (Late) A. N MELDRUM AND C. N. BAMJI: *6-Sulpho-m-cresotic Acid and Related Compounds.* G. V. JADHAV AND S. N. RAO, *Derivatives of 1-Hydroxy-2-Naphthoic Acid. Part II.—4-Halogeno-1-methoxy-2-naphthoic Acids and their Derivatives.* DUHKHAHARAN CHAKRAVARTI AND PHANINDRA NATH BAGCHI: *Synthesis of Coumarins and Chromones from 4-Chloro and 4-Bromo-1-naphthol.* D. G. WALAWALKAR: *A Note on Solid Sugars from Mohuwa Flower Syrup.* NRIPENDRA NATH CHATTERJI: *Phenanthrene from 9-Hydroxyphenanthrene (A Note).*

Calcutta Mathematical Society:

January 15, 1937.—H. LEBESQUE: *Sur certaines expressiones irrationnel'es illimitees.* E. T. BELL: *Numerical Functions of the Lattice points of xy......z< n.* C. V. HANUMANTHA RAO: *On an analogue of Gaskin's theorem.* R. R. SHARMA: *On Gaskin's theorem.* J. G. ANANDA: *On the inpolarity of a conic to a circle.* A. MOESSNER: *Numerische Identitaten.*

Meteorological Office Colloquium, Poona:

On 7-12-1936 Sir John Russell, F.R.S., Director, Rothamsted Experimental Station, addressed the Colloquium on 'Meteorology in Relation to Agriculture'.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

University of Mysore:

I. *Academic Council.*—A meeting of the Academic Council was held on the 23rd January 1937. Among the decisions arrived at, mention may be made of the following:—

(1) Introduction of an ordinance regulating the course of study in German for B.Sc. Honours students.

(2) Institution of separate minima for the papers, thesis and *viva voce* in the Master's Degree examination.

(3) Provision for the admission of L.M.P. diploma holders to the M.B.B.S. degree course, under certain conditions.

II. The following Extension Lectures were delivered:—

(*a*) Mr. A. R. Wadia, B.A., Bar-at-Law, Professor of Philosophy, Maharaja's College, on "The Charm of Hindi" in English, at Bangalore.

(*b*) Mr. K. Krishna Iyengar, B.A., Headmaster, National High School, Bangalore, on "Civic Discipline" in Kannada, at Mandya, Mysore and Bangalore.

III. A special lecture on "The Crisis of Contemporary Culture" was delivered at Mysore by Dr. Andrew Krzesinski, Professor of Philosophy, University of Cracow (Poland).

IV. Messrs. C. Narasimha Moorty, M.A., and D. K. Srinivasachar, B.Sc. (Hons.), graduates of this University, headed the list of successful candidates in the recent Mysore Civil Service Examination and were appointed as Probationary Assistant Commissioners.

212-37.—Printed at The Bangalore Press, Bangalore City, by G. Srinivasa Rao, Superintendent, and Published by B. N. Sastri, M.Sc., A.I.C., A.I.I.Sc., for the "Current Science" Board of Editors, Indian Institute of Science, Hebbal Post, Bangalore.

CURRENT SCIENCE

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CONTENTS.

The Silver Jubilee of the Indian Science Congress.

JST over 23 years ago, in January 1914, there met in Calcutta a Congress scientists presided over by Sir Ashutosh kherjee. The meeting lasted three days, Presidential Address and thirty-five pers were read, and the published prodings extended to eight pages. The seed as sown has now grown into the Indian ence Congress Association that we know the present day, with a total memberp of nearly 1,000, and a published prodings of over 600 pages.

he holding of the first meeting was nly due to the initiative of Professors . Simonsen and P. S. MacMahon, who nd, on coming out to India, that there ted in this country little opportunity scientific discussion, or for scientific kers coming into contact with one another. From the beginning the practice was adopted of meeting at different scientific centres each year, and up to now the Congress has met at Calcutta, Madras, Lucknow, Bangalore, Lahore, Bombay, Nagpur, Benares, Allahabad, Patna, Indore and Hyderabad. The Congress can thus claim to be a truly national body, representative of the whole of India. In fact, the annual meeting can best be described as the great scientific *mela* of the year, and all who are able to attend look forward to the event.

Next January the Congress will be celebrating its Silver Jubilee, and to commemorate the occasion, a delegation of about 75 scientists from the British Association and elsewhere, under the leadership of Lord Rutherford, will be coming out to

take part in the meeting. The session itself will be held in Calcutta, but for a fortnight before, the delegation will be touring in India, and visiting the more important scientific centres, thus emphasising the All-India nature of the celebration. This fine manner of celebrating the occasion is one that should appeal to all, and we are glad to be able to take this opportunity of supporting the feature.

The cost of inviting out such a large delegation will necessarily be large. The British Association, however, have agreed to meet half the cost of the expenses of the delegation. The Indian Science Congress Association have, therefore, to raise not only the other half of this amount, but also the local expenses of the meeting, and the cost of producing four commemorative volumes on science in India. In all about Rs. 75,000 will have to be raised by the Association, for it has no permanent fund of its own upon which to draw. Already a sum of Rs. 28,500 has been given or promised, of which the Government of India have generously contributed Rs. 20,000. About Rs. 46,500 therefore remain to be raised, and it is hoped that with the help of the Government of Bengal, with donations from Indian and British firms, from learned Societies, and from members of the public, it will be possible to raise the greater part of this sum. It is necessary, moreover, to appeal to individual scientists in India to contribute to the Jubilee fund, and it is this aspect that we particularly wish to stress in this place.

The benefits that will be obtained by the younger generation of research workers and students in this country, who will be able to meet the delegation and take part in the sectional meetings, can hardly be overestimated. Not only are all members of the delegation being asked to contribute papers, but special emphasis is being laid on the holding of discussions on subjects that are of mutual interest to both the members of the delegation and to scientists in India. The occasion will in fact be a unique one, and we believe that scientists in this country will be proud to feel that they can materially help towards its success. An increasing number of Indian scientists proceed every year to Europe to sit at the feet of eminent savants, or to collaborate with them in research work; and in drawing up the list of names of those scientists whose presence in India would be most appreciated, particular call was taken to include those who had come into contact with students from India. These members of the delegation in particular will be specially welcome in India, and we have no doubt that their coming will be an additional incentive to scientists in India to contribute generously to their expenses.

It is hoped to raise at least Rs. 10,000 in this way, and we have little doubt that it can be raised. It is essential, however, that it be raised quickly for the total number of delegates to be invited must, to some extent, depend upon the funds available. We shall from time to time publish in this Journal lists of contribution received from scientists, and we hope it will not be long before we can announce that the total aimed at, has not only been reached but passed. Donations should be sent direct to the Honornary Treasurer, Indian Science Congress Association, 1, Park Street, Calcutta, and they should be sent as soon as possible.

Ministry of Knowledge.

Sir James Colquhoun Irvine, C.B.E., D.Sc., F.R.S.
(*Vice-Chancellor, St. Andrews University.*)

THERE is in most of us a desire—often through sheer modesty unexpressed—to use our knowledge and experience for the common good; this is the impulse which may masquerade under that much-abused name "Service". Although sometimes pretentious, it is essentially a worthy impulse for, more than anything else, it justifies the years of effort spent in obtaining a higher education and the sacrifice of those who have made that privilege possible.

True, the opportunities for service which lie open to the young graduate are few and apparently trivial, but this does not mean that we should ignore them. A habit of mind comes with practice, and there is at this moment a special timeliness for the cultivation of that habit as the world stands in need of all the help we can give. The shallowest of optimists must admit that this is not a particularly happy age. Something has gone wrong with the world, and we search feverishly for hasty cures to meet sudden ills. The spread of education does not seem to have exercised any beneficial effect; indeed, it almost seems as if education had aggravated matters and the reason, as I see it, is that new knowledge is wrested from the unknown and poured into the world at a rate faster than man's feeble absorptive capacity can accommodate. Here is a new aspect of this age of speed.

The result is that we live under conditions which impose, to an extent never exceeded in History, the necessity for swift action to meet the sudden cataclysmic changes which assail mankind. To say this is not to repeat mechanically a platitude or to echo an idle fear, for it is a sobering truth that the world is moving too fast. I admit that civilisation has already passed through many periods when disorder and unrest threatened and, in the end, destroyed the peace which is man's natural inheritance. Equally, there have been times when a quick succession of discoveries—geographical, industrial and scientific—created new economic factors and produced confusion out of which order was slowly evolved. Yet, reflection convinces me that, since the close of the Middle Ages, civilisation has never been subjected to so many sudden shocks as in the age of discovery in which we live. It is not so much the multiplicity of these changing conditions which has baffled and perplexed us as the fact that the swiftness of their impact has caught us unprepared. Science and her foster-child invention have showered upon the world powers which have been rapidly exploited mainly for the individual gain of the moment and without regard for the greater good or for the future. No doubt it has always been the case that discovery has progressed in advance of man's intelligence and of his capacity to utilise new knowledge, but never before has man been given so little time to adapt himself to the impact of the new ideas he himself has evolved. While there is invariably a lag period between the origin of new knowledge and its applications, that interval has shrunk in our time almost to vanishing point until effect succeeds cause as swiftly as thunder follows lightning. We need not pause to multiply examples when we recollect that nearly two centuries of effort were required to transform early experiments on gas pressures into the steam engine and the locomotive, while less than a single generation has seen the development of the internal combustion engine to give the motor car and the aeroplane.

In more senses than one, we live in an age of speed, and speed brings its dangers. There is no alternative, than, but to act in advance by forecasting the channels down which discovery is likely to drive mankind and to frame national policies in accordance with these predictions. The few minutes of a graduation speech do not permit elaboration of this theme but surely it is not vain to hope that some day the machinery of Government will include as a matter of course a Ministry of Knowledge whose function, to put it in the briefest possible way, is to look ahead. When conditions, apparently stabilised, can be upset almost overnight by a single observation in a laboratory there is need for the finest intellects in the country to be set apart for the purpose of predicting the repercussions of new knowledge on all phases of life. Such an organisation would not invade

the province of existing departments of State, for its chief concern would be with the future rather than with the issues of the day and hour. Then, perhaps, it will be possible to frame in advance a national policy in which due regard is paid to such far-reaching problems as new sources of energy, such fundamental questions as to whether our coal supplies are to be used merely for power or as raw material for manufactured products, whether our forests —long-dated investments at the best—will be utilised for the purposes for which they were planted or devoted to alternative uses already looming in sight. Had there been in existence thirty years ago such organised legislation as I have suggested the world might well have been saved from at least some of the devastation created by unemployment; we would at least have been spared the humiliation of seeing the policy of international sanctions put into effect without sufficient preparation in advance of the moment of emergency. These are but examples; yet they are sufficient to show that all public departments—trade, education, health and defence included—would benefit in the end if trained intellects were entrusted in this way with the hazardous role of the prophet.

These are large issues and I must remember that I am speaking not on a political platform but to graduates of a Scottish University. If the larger problems to which I have referred must, for the time being, lie beyond the range of your effective help— our Ministry of Knowledge is still a dream— there remains much in which you can play a part, if only on a modest scale and within a shorter radius.

—(*From a speech delivered by Sir James Irvine at the Graduation Ceremony held at St. Andrews, June 1936.*)

Science and the Indian Oil Industry.

By P. Evans.

(*Burmah Oil Co., Ltd., Digboi.*)

Historical.

Introduction.—Such familiar words as aeroplanes, motor cars, diesel engines, are surely as representative of modern transport as any words can be, and they suggest to us the important part played by petroleum and its products in civilisation. We are apt to forget that some petroleum products have been known for centuries, and it is perhaps a little surprising to learn that when Julius Cæsar put asphalt on his roads he was merely following the example of Nebuchadnezzar. The use of oil in India —or at least Burma[1]—although it can hardly claim such antiquity, goes back to very ancient times. The source of the oil was Yenangyaung, some 300 miles up the Irrawaddy, where wells were dug by hand to very considerable depths. The oil served a variety of purposes—it was used as a preservative of wood work, as a medicine, for lubricating, and as an illuminant. In other parts of the world oil was collected from seepages, small pits, hand-dug wells, and occasionally by accident from wells bored for water.

Early Drilling.—It was not until after the middle of the nineteenth century that any attempt was made to drill wells specially for oil, using regular machinery, the earliest American oil-well being completed in 1859, and from this time dates the beginning of the modern oil industry. It is of interest that as early as 1866 an attempt was made to develop the oil of Assam, and wells were drilled there, although without much success, before actual drilling started in Burma. In 1869–70 wells were drilled in the Punjab, but also without success.

Shortly after this, oil refining was commenced in Rangoon, the oil being floated down the Irrawaddy in large earthenware jars from the Yenangyaung field, where it was worked by certain Burmans known as Twinzas. After the deposition of King Thibaw, the Twinzas' rights were confirmed, and portions of the oil-field allocated as

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[1] In these notes, India is throughout taken as including Burma.

'Reserves'. The remainder became Government property and was leased for drilling. The first machine-drilled well was completed in 1889, although unsuccessful drilling in Lower Burma dates from the seventies.

A little before this development at Yenangyaung, renewed attempts had been made to find oil in commercial quantities in Assam, and the first regular producer was completed in 1890. The yield was very small, and gradually dwindled, but this well still produces an occasional gallon of oil. Attempts at development in Assam continued in a small haphazard way without meeting much encouragement, and very little was done in the Punjab, but the results of drilling in Burma from about 1896 onwards were much more satisfactory, although until 1907 only one company was operating.

Burma.—After the successful results of drilling at Yenangyaung, wells were drilled at Yenangyat, where there were a few hand-dug wells, and at Singu a field—discovered as the result of the geological work of G. E. Grimes of the Geological Survey of India—has since become second in importance to Yenangyaung. Small oil-fields were found in the Minbu, Thayetmo and Chindwin districts, but despite active prospecting work carried on unremittingly by several companies for many years, the only important discovery subsequent to Singu was the Lanywa field, proved in 1921 and successfully developed on a sand-bank area reclaimed from the Irrawaddy. Continued development has taken place at Yenangyaung, from which has come nearly two-thirds of the total oil obtained from Burma.

Assam.—Despite active prospecting, on which over two crores of rupees have been spent, Digboi is still the only producing field in Assam. Production here was very small prior to 1925 when a more active and scientific development policy began to bear fruit. The Badarpur field, proved in 1915, was exhausted eighteen years later.

N. W. India.—Here too, there has been much prospecting work in the Punjab, N. W. Frontier Province, Sind and Baluchistan, but only one field (Khaur, discovered by Mr. E. S. Pinfold) has been commercially developed, although a test well in a neighbouring area has recently given promise of a second field.

PROSPECTING METHODS.

Origin of Oil.—The location of the early wells, both in America and elsewhere, was largely a matter of chance, the sites being usually near oil seepages, but these hit-or-miss methods provided much information about the geological conditions governing the occurrence of workable accumulations, and the gradual co-ordination of this knowledge has brought out some of the essential factors in the origin, concentration and preservation of oil, although much detail remains to be investigated. The presence of optically active constituents and the nature of the oil-bearing strata show that oil is not, as was once supposed, of inorganic origin. Petroleum occurs in the pores and minute interstices of sands and in crevices in limestones, and is always closely associated with old sediments which are usually of shallow water marine origin. The oil is derived from organic matter decaying in certain special conditions in which there is incomplete oxidation of the carbon and hydrogen; at first disseminated throughout the geological formation in which it originated, the oil is gradually forced to migrate into the more porous beds. If the oil-bearing strata are in one of the more unstable parts of the earth, buckling and folding take place as portions of the earth's crust become warped, cracked and piled up to form the mountain ranges. If the movement is not too violent, the petroliferous strata may lie in fairly gentle corrugations, and if such be the case the oil, being lighter than water, will drain *upwards* into the arches of the corrugations, there becoming concentrated in what may be commercially valuable quantities. In unfavourable circumstances, the earth movements are violent enough to break up the folds and let the oil escape; in many instances the progress of denudation removes the strata capping the oil-sand, and the oil is lost.

Factors governing the Occurrence of Oil-fields.—Oil production may be looked for where the geological conditions are such as to suggest

(1) that oil was formed in the neighbourhood,
(2) that the oil disseminated throughout a large area was concentrated,
(3) that the oil has not since been lost at the surface,

and it is evidently the task of the geologist

to estimate the probability that these requirements are fulfilled.

The arched-up portions of the folded strata are known as anticlines and it has been suggested that the connection between oil-fields and anticlines was first noticed by T. Oldham (the first Superintendent of the Geological Survey of India) in 1855 during a visit to Burma, but Oldham's account of his visit does not seem to bear this out, and he certainly did not develop any hypothesis to connect oil with structural conditions. The anticlinal theory of oil accumulation was put forward in the eighteen sixties and led to much discussion; for many years there was no general recognition of the principles of oil accumulation, and it was not until the beginning of the present century that scientific exploration began effectively to supersede the old methods of chance.

Establishment of Geological Staffs.—The demand for petroleum products had steadily increased from about 1870 but with the development of the internal combustion engine there was a rapid rise in the demand, especially noticeable in the first years of the twentieth century, and in response to this most of the oil companies of the world established small geological staffs, whose business it was to search for new supplies. The science of oil geology had still to be built up, and it was not until the second decade of this century that the young science could boast a text-book of its own or special courses leading to a university degree.

The War directed special attention to the importance of petroleum and soon afterwards there was a large increase in the scientific staffs of the oil companies. Mr. Dewhurst has summarised the results of this rapid expansion:

> "With these staffs it was possible to conduct surveys of extensive regions much more systematically than had formerly been the case, and for the first time to arrange for members of the staffs to specialise in different directions, so that one geologist could undertake palæontological work, another sedimentary petrology, and others the application of laboratory methods to routine work on oil-fields and to researches into oil-field problems."[2]

Mr. Dewhurst has also pointed out that the greatest change which took place was in the oil-fields themselves. In the earlier days, with shallow drilling, the geologist had little to do with the location of the new wells or the depth to which they should be drilled; his work centred on the exploration of new territory. In the post-War period the geologist's responsibilities broadened, and now the development of most of the proved fields is carried out with the assistance of the scientifically trained man, whether he be called geologist or technologist.

Although these comments on the part played by science in the discovery and development of the oil-fields are applicable to the oil industry as a whole, they are particularly applicable to India, and it is very satisfactory that the country's oil resources are being developed with due regard to the prevention of waste, which is unfortunately not the case in every country.

Geological Mapping.—The oil geologist seeking new fields will commence by compiling a geological map of his territory, making his own reconnaissances to supplement the available information. Often he will soon be able to rule out most of his territory as useless to an oil company, but in parts of the area he may find the right type of strata, and perhaps surface indications of oil. He will then pay special attention to the structure of this tract to find suitable anticlines or possibly other structures in which oil may be trapped. The most favourable structures are mapped in detail, and many hundreds of square miles in India and Burma have been mapped on scales ranging from 4 to 16 inches per mile. Of the areas examined, some few may appear fairly promising, in others the oil strata may be too deep, or in others the structure may not be suitable to have trapped and retained the oil; eventually one or two may be recommended for drilling. Unfortunately, despite the advances in geological science, it is impossible to be certain of the existence of commercially workable accumulations of oil; it is impossible to evaluate all the factors, and the only arbiter is the drill, and it is an indication of the difficulties of oil prospecting that only 1 in 4 of the exploratory wells find paying quantities of oil. This may, however, be contrasted with the older days when, despite the existence of many shallow

[2] T. Dewhurst, in *Petroleum, Twenty-five Years Retrospect, Inst. Petr. Techn.*, 1935.

fields waiting to be found, only 1 in 20 exploratory wells were successful. The difficulties and expense of oil prospecting are well brought out by the fact that the six leading companies in India have spent six crores of rupees in unsuccessful exploratory wells drilled on geological advice. It will be evident that the geologist, equally with the shareholder and the directorate, will be always on the alert for new ways of investigating underground conditions, and within very recent years there has developed the geophysical side of oil prospecting.

The geophysicist employs a variety of instruments ; the torsion balance has been most successful, but the seismograph, magnetometer and potentiometer have been used in various countries. The torsion balance measures the variations in gravity from place to place ; from these it is often possible to deduce something of the underground geological structure. The interpretation is difficult, but where large areas are covered by alluvium, the torsion balance may be the only means of finding out anything about the structure. The seismic method depends on the determination of the reflections and refractions of artificial earthquake waves and except in a few simple cases, interpretation is usually even more difficult and uncertain. Magnetic anomalies, helpful in prospecting for iron, are seldom of assistance in the search for oil, but electrical methods, based on the differences in conductivity of different strata, have had limited application.

Other adjuncts to the work of the field geologist are the aeroplane, for reconnaissance of a large area, and the core-drill, for putting down shallow bores to check the structure in obscure territory ; for assistance in correlation problems are the museum and laboratory methods of palæontology, micro-palæontology and micro-petrology.

Oil geologists in India have not been slow to make use of these possible means of gaining additional knowledge. Geophysical work was commenced as far back as 1923 and has been carried out in several different regions, aerial reconnaissance and aerial photography were used in 1934, core-drilling has had some employment, and the museum and laboratory methods have been very highly developed. It may fairly be claimed that in several directions the oil geologists of India have carried out pioneer work in the development of their science and for many years past the search for oil in India has been pushed forward with all the assistance that the developing science could give.

Drilling.

There are several methods in use for drilling oil-wells, but the most modern method, and the one extensively used for all the deeper drilling in India and Burma, is the rotary system. A bit is rotated at the end of a drill-pipe made in sections of 20–30 feet. This bit is withdrawn from time to time when the cutting edges become dull. To cool the bit, to bring up the cuttings of the strata drilled through, to control the inflow of fluids encountered in porous beds, and to plaster up the sides of the hole, a fluid is circulated down inside the drill-pipe, around the bit, and up outside the drill-pipe. This fluid is composed mainly of clay and water but even this apparently simple mixture presents problems of great scientific interest and technical importance, and one of the applications of science to the oil industry of to-day is the close study of this drilling fluid by chemists, geologists and engineers. The completed hole has to be lined with steel casing and arrangements made to permit the ingress of oil but to prevent water coming in as well. Water is excluded by placing cement between the casing and the strata drilled through, and the preparation and handling of a suitable cement involve scientific problems of some importance around which a large literature has grown up.

If the well is exploring new territory, all manner of unforeseeable difficulties may occur and it may need several wells to reach the objective, the successful one being drilled with some knowledge of the difficulties that have proved the ruin of the earlier ones. In a developed field, the geologist will be able to give fairly accurate figures for the depths at which different formations may be expected, and the proportion of successful completions should be high.

Twenty years ago, wells were considered fairly deep at 2,000–3,000 feet, but to-day such depths are regarded as shallow, and wells have been taken to depths exceeding 10,000 feet. This increase has been made possible by the science of metallurgy, for the tensile strengths of the older steels were quite inadequate for drilling to such great depths. Although drilling in India has not gone to the depths reached in America, holes have been carried down to depths exceeding

a mile and a half and some of the drilling has been in very difficult territory.[3]

One feature of drilling to great depths is the difficulty of keeping the hole nearly vertical, and numerous devices have been evolved to survey the wells at various stages during drilling. Some of these are very intricate, making use of the gyroscopic compass, others are comparatively simple, using in some cases a magnetic compass. Five different patterns of surveying instrument have been used successfully in India, two being the design of geologists working with one of the oil companies. It is evident that a knowledge of the underground position of wells in a developed field is of the utmost importance, and it can be fairly claimed that in this respect India is in no way behind the most advanced American practice.

The recognition of the strata drilled through presents difficulties, especially in the deeper wells ; this problem has received much attention in India, as in other countries, and a recent advance of great importance is the adoption of an electrical method, based on potentiometric determination of conductivities, for distinguishing the different strata drilled through.

Production and Development.

The production of an oil-well usually declines steadily, or perhaps rapidly, from the day the well is completed, and to keep up the ouptut of an oil-field there must be continual drilling to offset the diminishing yield of the existing wells. The correct spacing of wells, the order in which they should be drilled, and the general plan of development are matters which, once left largely to the accident of circumstances, are now given very careful consideration. In countries where unrestricted competition goes on, this scientific planning is not always possible, for there is too large a premium on the 'get there first' policy.

The detailed elaboration of the scientific principles underlying the production of oil and gas is still in the stage of debate ; the oil occurs in the pores and crevices of a sand or limestone under pressures and conditions very difficult to imitate in laboratory experiments. The oil usually contains a large proportion of hydrocarbons which under normal pressure would be gaseous ; the puncturing of an oil-sand by a well brings about a great local reduction in pressure and there is a brisk evolution of gas. This gas, escaping towards the well through the capillary passages in the sand, carries along with it some of the oil. In this way the oil reaches the well, and if the pressure is sufficient, comes up to the surface. The aim of the production technologist is so to control the conditions at the well that there is produced the maximum amount of oil per unit volume of gas. Otherwise, if gas is wasted, a volume of inert oil remains in the sand with no special inducement to come into the well, production falls off rapidly, and the well ceases to yield oil in quantity long before it should ; the oil-sand is not properly drained, and when the field becomes exhausted there is still a large but unrecoverable volume of oil in the sand.

This and cognate problems have received much attention on the Indian as on other fields ; the trouble is accentuated by the complex surface tension relationships in the capillaries of the sand, and the difficulties of making measurements at the bottom of a well. It is generally agreed that the more prolific wells should be restricted to produce at less than their maximum rate, as this tends to retard the loss of gas. The production of some gas is unavoidable, since each unit volume of oil in the sand contains many volumes of gas, but attempts have been made in Indian fields, as elsewhere, to return this gas to the sand, so as to retard the inevitable drop in pressure in the oil-sand as production continues.

Although in the early stages of a well's life the oil may come right up to the surface, the drop in underground pressure which necessarily follows the extraction of the oil will sooner or later make it necessary to adopt some means for bringing the oil up to the surface. This may be direct pumping or the use of 'gas lift' which is similar to the air lift sometimes employed for water wells.

In many American fields much waste has resulted from unrestricted competition ; the small operator with only a few wells may develop his property in a way that may be very harmful for the field as a whole. Unless each individual oil-field is treated as a unit, or the different operators are prepared to agree to gas conservation, development designed to extract the greatest possible

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[3] *Rec. Geol. Surv. Ind.*, 1935, **69**, pt. 3, 284 ; *J. Inst. Petr. Techn.*, 1934, **20**, 990.

amount of oil is impossible. Early in the present century, the Geological Survey and Bureau of Mines in the U.S.A. were endeavouring to minimise this waste, but the individual ownership of mineral rights has meant that in the great majority of fields, the oil is the property of a large number of surface owners, and conflicting interests have made effective co-operation difficult or impossible. In India, fortunately, the mineral rights in the oil-fields are, with a few exceptions, the property of the State, and in several cases a field is worked by only one company. Provided that the company can count on the continued renewal of the lease so long as satisfactory work is carried on, it is possible to plan out the development so as to aim at getting the greatest ultimate yield of oil.

In the fields in Burma which are developed by several competing interests, drilling practice is regulated by the Warden of the oil-fields who is assisted by an Advisory Board which includes a member of the Geological Survey of India and representatives of the various companies. In this way such occurrences as the damage to oil-sands by water getting into them from improperly drilled wells are prevented, and everything possible is done to avoid the waste of irreplaceable natural resources of the nation and to ensure that all engaged in the development of the field—whether their interests were large or small—conduct their operations in a manner consistent with the welfare of the field as a whole.

Refining.

The oil when brought to the surface is of little immediate use, and has to go through a long series of refining processes before the familiar products appear in a form fit for use. The successful refining of oil calls for the closest co-operation between those engaged in chemical research, applied chemistry and engineering. The basis of the main process of refining is fractional distillation, but fractional distillation on the vast scale of an oil refinery is a very much more complex process than when carried out on the laboratory bench. In place of the few hundred c.c. there are hundreds of tons to be handled, and the process must be as nearly as possible a continuous one. Modern refining methods go far beyond simple distillation ; the products must conform to a precise specification of boiling points, specific gravity, colour, etc., and to attain these, numerous subsidiary treatments are given. The operation of all these processes is in the charge of the control chemists who are assisted by the laboratory tests carried out from hour to hour on the various products.

Refining processes must be adapted both to the character of the crude oil and the requirements of the markets for products of different types, and improvements in the refineries are continually being made as improved processes become available ; for example, research has been concerned with the effects of sulphur compounds in the oil, with the elimination of smokiness, with the enhancement of lubrication, with the production of petrols suitable for engines employing ever higher and higher compression ratios, and with many other problems. Perhaps the most notable advances in refining have been in connection with the 'cracking' processes which were first used in a small way some thirty years ago, and which have now become an essential part of the treatment of crude oil. The object of cracking is the production of a light spirit from heavy oils by breaking down the complex molecules, and the advantages are the ability to produce a more useful range of products from the original crude and the high 'anti-knock' value of cracked spirit. The most widely used is the Dubbs process, and there are several Dubbs units working in the Indian refineries.

Scientific Staffs.

Geological Staff.—The foregoing notes will have indicated that the oil-field geologist is interested in a great variety of problems ; during the drilling of the well there are, to take but a few examples, the interpretation of its log and correlation of the strata with those of neighbouring wells, the surveying of the underground course of the well, the determination of the depths at which water and oil may be expected ; it is his task to analyse the results obtained by the different wells, and from this evidence to plan out on the best possible scientific and economical basis a development programme for the field ; often, in conjunction with the physicist and engineer, he is concerned with the methods by which the oil shall be brought to the surface. In all this work, his geological knowledge will

have to be supplemented by some knowledge of other sciences, especially physics, chemistry and engineering, and he is often referred to as an oil technologist rather than an oil geologist. The geological staff may include specialists such as a petrologist, a palæontologist and a geophysicist.

Chemists' Staffs.—Besides the geological staff, there may be a staff of chemists to deal with such oil-field problems as the analysis of the oil, gas and water obtained from the wells, and the investigation of the properties of the mud-fluid and cement used in drilling the wells.

In the refinery there are research chemists who investigate the products obtained from the oil and devise methods of improving them and their manufacture, and the control chemists who are responsible for all the varied processes of making the products and the routine testing which ensures that they are up to the specified standard.

Engineering Staff.—The engineering staffs may include men who are allocated to special enquiries into various aspects of drilling and production methods, and to the development of new devices for improving oil-field practice. Much work has been done in the application of electrical power to drilling and production, and recently there have been contributions to the technique of drilling under pressure as a result of the difficulties encountered in drilling in India.

Medical Staff.—Although this review is concerned mainly with the direct application of science to the technical problems associated with the production of oil in India reference must be made to the medical staff whose labours in hygiene and preventive medicine have such an important influence on the health and comfort of the oil-field worker.

Publications.—The scientific work of the oil companies is necessarily intended primarily for the benefit of the companies concerned, and in many cases it is not possible to divulge the results, whilst in other cases the results cannot be made available until the company concerned has made full use of them. Despite this, the scientific staffs of the oil companies in India have been able to make valuable contributions to different branches of knowledge—geology, chemistry, physics, engineering. In recent years papers have been written by more than twenty members of the various oil companies' scientific staffs. A notable example is the contribution by men with Indian experience of a large number of papers to the World Petroleum Congress in 1933.[4] Papers based on the scientific work of the oil companies of India have appeared in the publications of the Geological Survey of India, the Royal Asiatic Society of Bengal, the Mining and Geological Institute of India, the National Institute of Sciences of India, the Indian Science Congress, the Geological Mining and Metallurgical Society of India, and also in English and American publications such as the *Journal of the Institution of Petroleum Technologists*, the *Bulletin of the Geological Society of America*, the *Bulletin of the American Association of Petroleum Geologists*, *Oil Weekly*, *Oil News*, etc.

Geological Survey of India.—Finally, no account of the scientific side of the oil industry would be complete without reference to the work of the Geological Survey of India. The first paper on petroleum in India appeared in the *Records* as far back as 1870, and since that time more than sixty memoirs and papers have been published dealing with the work of the Geological Survey in connection with oil. The past twenty-five years include the detailed memoirs of Sir Edwin Pascoe and Mr. C. T. Barber, besides the writings and work of Sir Thomas Holland, Messrs. Vredenburg, E. J. Bradshaw and Dr. Ghosh and of several other members of the Geological Survey, in addition to the valuable annual and quinquennial reviews.

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[4] Reviewed in *Trans. Min. Geol. Inst. India.*, 1934, **29**, 67.

LETTERS TO THE EDITOR.

A Note on the Relation between Fisher's 't' and 'z'.

In any experiment containing variants and a control for comparison the significance of the difference among and between the variants and the control is compared by ascertaining the value of 'z' $= \frac{1}{2}\log S_1^2/S_2^2$, where S_1^2 and S_2^2 are the residual variance and variance ascribable to variants respectively. The value of 'z' by comparison with the theoretical values enables us to judge the general effect of treatments. To see the effect of treatments when compared with one another, use is made of Fisher's 't'. The exact relation between 't' and 'z' for field experiments containing more than two treatments does not appear to have been worked out so far. The relation between the various possible values of 't' and 'z' may be stated thus:

Let the means of n treatments replicated p times be given by T_1, T_2, T_3, $T_4 \ldots T_n$. The number of possible comparisons between the various means is equal to $\frac{n(n-1)}{2}$. The sums of squares of 't' for all the possible comparisons is equal to

$$\frac{p(T_1-T_2)^2}{2S_1^2}+\frac{p(T_1-T_3)^2}{2S_1^2}+\frac{p(T_1-T_4)^2}{2S_1^2}+\cdots \text{ to } {}_nC_2 \text{ terms}$$

$$=\frac{p}{2S_1^2}\left\{(T_1-T_2)^2+(T_1-T_3)^2+(T_1-T_4)^2+\cdots \text{ to } {}_nC_2 \text{ terms}\right\}$$

$$=t_1^2+t_2^2+t_3^2+\cdots t^2_{\frac{n(n-1)}{2}}=\frac{n(n-1)}{2}\bar{t^2}$$

where $\bar{t^2}$ is the average of all the t^2's that can be formed.

It can now easily be shown that

$$\frac{p}{2}\left\{(T_1-T_2)^2+(T_1-T_3)^2+(T_1-T_4)^2+\cdots \text{ to } {}_nC_2 \text{ terms}\right\}=\frac{n(n-1)}{2}S_2^2,$$

S_2^2 being the variance due to treatments.

Therefore it follows that $t^{-2} = S_2^2/S_1^2 = e^{2\varepsilon}$.

This result can be used for several purposes and these will be dealt with in detail in a subsequent communication.

P. V. KRISHNA AYYAR.

Imperial Agricultural Research Institute, New Delhi,
February 2, 1937.

The Emission Spectrum of CCl_4.

THE spectrum of an uncondensed discharge through flowing CCl_4 vapour (pressure maintained between 0·2 and 0·3 mm. of Hg) shows a number of continuous emission bands the wave-lengths of whose maxima are approximately at λλ 4600, 3348, 3070, 2580, 2430 and (2345 ?). In addition, the plates show a group of strong bands between λλ 2796 and 2777 and two more groups of weaker bands on either side of this region all degraded towards shorter waves. In appearance these bands resemble very much the group of bands observed in the spectrum of the vapour of $SiCl_4$ between λλ 2830 and 2770 and whose emitter is not yet definitely established.[1] Fig. 1 is an enlarged reproduction of the observed bands. Some of the bands have a sharp, line-like head as in these latter bands. It has been possible to arrange them in the usual ν' ν'' table.

$\nu'' \backslash \nu'$	0 λ air	0 ν vac	Δν	1 λ air	1 ν vac
0	2795.9 (6)	35756	826	2862.0 (0)	34930
	†2789.5 (8)	35838	846	2857.0 (4)	34992
	†2782.4 (8)	35930 —137—	845	2849.4 (4)	35085
	†2778.9 (6)	35975	848	2846.0 (4)	35127
Δν	846			862,863	
1	....			....	
	....			†2788.3 (8)	35854
	....			....	
	2713.4 (0)	36843	853	†2777.7 (8)	3599(

† Sharp, line-like head, or strong line superpos on head.

Figures in brackets denote visually estimat intensities.

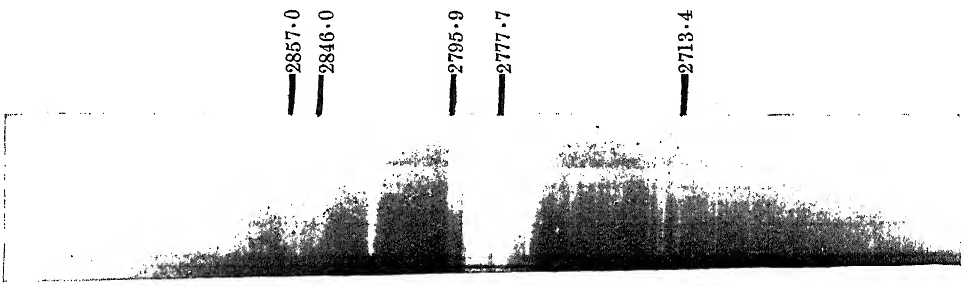


Fig. 1.

The analysis indicates that the bands are due to a diatomic molecule. It is not possible to derive the vibrational functions but $\omega''_{\frac{1}{2}}$ 843·6 (mean of all observad values) for the final state indicates that the emitter is probably the CCl molecule which approximately will have the same frequency of vibration as SiF in the ground state for which $\omega''_{\frac{1}{2}}$ is 844·7 (mean of all observed values[2]). If this is true the bands observed are due to a transition $^2\Sigma \rightarrow {}^2\Pi$ in the C molecule. In analogy with SiF, SiCl, etc. t ground state is a $^2\Pi$ level with a separati of 136 cm.$^{-1}$ as compared with 161·1 cm.$^{-1}$ in the case of the iso-electronic mole SiF.

A detailed report will be published e where.

R. K. ASUNDI.
S. MUJTABA KARI

Department of Physics,
Muslim University,
Aligarh,
February 27, 1937.

---

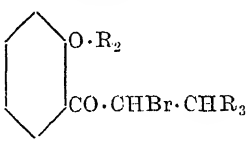
[1] W. Jevons, *Proc. Phys. Soc. London*, 1936, **48**, 5

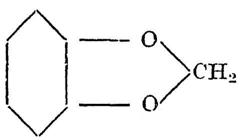
[2] R. K. Asundi and R. Samuel, *Proc. Ind. Acad Bangalore*, 1936, **3A**, 346.

Action of Alkalis on the Dibromides of *o*-Acetoxy- or *o*-Hydroxy-phenyl styryl ketones and a New Synthesis of Chrysin (5 : 7-Dihydroxyflavone).

It is well known that *o*-acetoxy -or *o*-hydroxy-phenyl styryl ketone dibromides yield with alcoholic alkali either flavones or the isomeric benzylidenecoumaranones. Auwers and Anschütz[1] showed that low temperatures favoured the production of flavones, but were unable to give a satisfactory explanation of the formation of two products, beyond suggesting that there were two simultaneous reactions occurring.

The majority of dibromides which readily yield benzylidenecoumaranones are of the type R·CO·CHBr.CHBr-R_1 in which R_1 contains an alkoxyl group. It is known that with dibromides of this type the bromine atom adjacent to R_1 is labile and is readily replaced by alkoxyl on warming with the corresponding alcohol.[2] It seems plausible, therefore, to regard the alkoxy-compound as an intermediate in the production of a benzylidenecoumaranone. Table I shows the results of a number of experiments carried out with :—





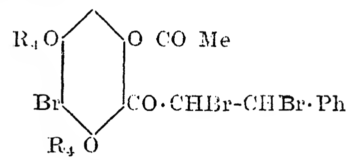
I. R_2 = COMe; R_3 = Br. Feuerstein and Kostanecki.[3]

II. R_2 = H; R_3 = Br. Prepared by the careful bromination of the corresponding chalkone.

III. R_2 = H; R_3 = OEt. Prepared by boiling 1 or 2 with ethyl alcohol.

A survey of the results indicate that for the production of the benzylidenecoumaranone from I or II, it is essential that there be present hot ethyl alcohol which will form III, together with sodium hydroxide or sodium carbonate. With III it suffices if sodium hydroxide or sodium carbonate be present, neither alcohol nor heat is necessary. III would therefore seem to be intermediate in the production of the benzylidenecoumaranone.

There are two acetoxy-chalkone dibromides (IV and V) which give benzylidenecoumaranones on warming with alcoholic alkali although R_1 does not contain an alkoxyl group.[4]



(IV, R_4 = Me; V, R_4 = Et)

It is hoped to investigate the behaviour of IV and V on the lines indicated in Table I.

Table I

F Flavone C Benzylidenecoumaranone

Reaction	Result with I (Acetoxy)	Result with II (Hydroxy)	Result with III (Ethoxy)
Heating above melting point	F	F	F
Heating with pyridine	F	Product containing halogen, m.p. 234–235 °C., still under investigation	F
NaOH acetone hot or cold	F	F	C
Na_2CO_3 acetone hot or cold	No definite product	F	C
NaOH or Na_2CO_3 alcohol, cold	F 1)	F	C
NaOH or Na_2CO_3 alcohol, hot	C 2)	C	C

1) NaOH, Alcohol, cold, Auwers and Anschütz, *Ber.*, 1921, **54**, 1558.
2) NaOH, Alcohol, hot, Feuerstein and Kostanecki, *Ber.*, 1899, **32**, 316.

Meanwhile, 2-hydroxy-4 : 6-dimethoxy-phenyl styryl ketone has been brominated and the product heated to give a flavone which on treatment with hydriodic acid yielded chrysin; the constitution of the latter being confirmed by taking a mixed melting point with an authentic specimen kindly supplied by Dr. K. Venkataraman. Kostanecki and his co-workers failed to synthesise a number of natural flavones by the dibromide method owing to the formation of benzylidenecoumaranones; there now seems a possibility of achieving their aim.

2-hydroxyphenyl $\alpha\beta$-dibromo-β-phenyl-ethyl ketone now newly synthesised, which decomposes near 200°C., gives 6-bromoflavone on heating and with alcoholic sodium hydroxide gives flavone. No formation of an alkoxy-compound occurs here.

A. M. Warriar.
A. P. Khanolkar.
W. A. Hutchins.
T. S. Wheeler.

Royal Institute of Science,
Bombay.
February 14, 1937.

[1] *Ber.*, 1921, **54**, 1543.

[2] See for example, Dodwadmath and Wheeler, *Proc. Ind. Acad. Sci.*, 1935, **2**, 438.

[3] *Ber.*, 1899, **32**, 316.

[4] See Kostanecki and Tambor, *Ber.*, 1899, **32**, 2261.

A Penta-Co-ordinated Cobaltic Complex and its Magnetic Susceptibility.

In course of our work on substituted cyanocobaltiates we have come across with an unusual type of co-ordination compound which, as its magnetic susceptibility indicates, evidently belongs to the class of perfect complexes.

The compound resulted from the dehydration of aquo-pentacyano-silver cobaltiate, a member of a new series of cyano-cobaltiates recently prepared by us. The formula for the compound is given by $Ag_2[Co(CN)_5]$. Its colour is intensely blue, whereas that of the corresponding hydrated complex $Ag_2[Co(H_2O)(CN)_5]$ is yellow.

The yellow compound is diamagnetic like all cobaltic complexes. The blue compound shows only a feeble paramagnetism amounting to 1·97 Weiss's magneton number per cobalt atom. As cobaltic cyanide and other simple cobaltic salts[1] are strongly paramagnetic giving a susceptibility value of 13·6 Weiss's magneton per cobalt atom, it is clear that the compound is a perfect complex like all complex cobaltic salts. But it is unique in the sense that its co-ordination number is only five, whereas all tervalent elements, specially cobalt, are characterised by a co-ordination number of six. The effective atomic number for the central cobalt atom in this compound is, therefore, 34 and not 36 as in all other cobaltic complexes.

That a central atom with an effective atomic number of 34 in a complex can be diamagnetic, has already been shown by one of us (Rây) in the case of a number of nickel complexes like nickel dimethylglyoxime, nickel dicyandiamidine, nickel biguanide, etc.[2]

P. Rây.
N. K. Dutt.

Chemical Laboratory,
University College of Science,
Calcutta,
February 18, 1937.

[1] Rây and Guptachaudhuri, *Z. anorg. u. allg. Chem.*, 1934, **220**; Rây and Sen, *J. Ind. Chem. Soc.*, 1935, **190**.

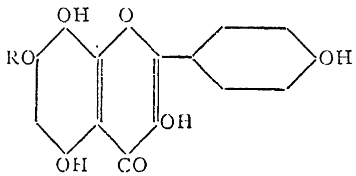
[2] Rây and Bhar, *J. Ind. Chem. Soc.*, 1928, **497**; Rây, *Presidential Address—Indian Science Congress*, 1932.

Constitution of Herbacitrin and Herbacetin.

The isolation of a new flavonol glucoside from the flowers of *Gossypium Herbaceum* (Uppam cotton) was recorded in a paper from these laboratories more than a year ago.[1] Though the constitutions of the flavonol and the glucoside were known to us at that time, the publication of the results were postponed till they could be confirmed by synthesis.

Since there exists already a compound with the name Gossypitrin obtained from the same source, the new glucoside was named Herbacitrin and the aglucone (flavonol) Herbacetin. These have been found to occur in *Gossypium Indicum* also. The glucoside has the formula $C_{21}H_{20}O_{12}$ and the flavonol the formula $C_{15}H_{10}O_7$ and so they are isomeric with Quercimeritrin and Quercetin respectively to which they bear

some resemblance particularly in regard to the melting points. On closer examination the differences become evident, the most remarkable being in their reactions towards buffer solutions of varying p_H values and towards *p*-benzoquinone. In these Herbacitrin resembles closely Gossypitrin and Herbacetin resembles Gossypetin thus indicating that the benzopyrone portions of these pairs are identical. Hence the following constitution seemed plausible :



Where R is H or $C_6H_{11}O_5$

This was confirmed by the oxidation of the glucoside in aqueous alkaline solution whereby *p*-hydroxy-benzoic acid was obtained and identified after methylation as anisic acid. The position of the glucose is tentatively suggested by analogy with Gossypitrin and Quercimeritrin.

Herbacetin has now been synthesised in the Dyson Perrins Laboratories in Oxford (Private communication from Prof. R. Robinson, F.R.S.). The synthetic flavonol and its acetyl derivative have been compared by him with the specimens obtained from the cotton flowers and found to be identical thus placing the above constitutions beyond doubt. Details of our work will be published in the *Proceedings of the Indian Academy of Sciences*.

K. NEELAKANTAM.
T. R. SESHADRI.

Department of Chemistry,
J.V.D. College of Science and Technology,
Waltair,
February 15, 1937.

[1] *Proc. Ind. Acad. Sci.*, A, 1935, **2**, 490.

A New Value for Butter-Fat and Ghee.

GHEE (Butter-Fat) is most widely adulterated and the most extensively used adulterants at the present time are the hardened vegetable and fish oils and other solid fats like mutton and beef fats. On account of the wide range of Reichert-Meissl values given by genuine ghee, this value fails to detect even up to 30 per cent. adulteration in many cases. Determinations of the melting point of sterol acetate and the percentage of iso-oleic acid fail to detect adulteration with highly hardened fish oils and mutton and beef fats. The Ave-Lallemant Baryta values follow the Reicherts and fail in the case of genuine ghee samples of low Reicherts. It will, therefore, be seen that there is no easy and reliable method available at present to detect marginal adulterations with the adulterants mentioned above.

The author has worked out the following new value for butter-fat and ghee by means of which even 10 per cent. of any of the above adulterants can be detected. The value is most easy to determine and independent of Reicherts for genuine ghee and is surprisingly the same for cow's and buffalo's ghee.

The value is not intended to detect untreated vegetable oils, the detection of which by the ordinary methods, however, presents no difficulties.

The insoluble non-volatile acids of pure ghee consists mainly of a mixture of lauric, myristic, palmitic, stearic and oleic acids whereas in the hardened oils mutton fat, etc., stearic and oleic acids predominate. This difference in composition is made use of in the new value.

The insoluable fatty acids left after the distillation in the Reichert-Polenske process is separated out, washed and dried. The solidifying point or 'titre' is determined in a suitable small titre-apparatus. The refractive index of the mixed acids is accurately determined at 45° C. in an Abbe Refractometer.

The following formula enables one to calculate the new value :

$$T + (N^D_{45} - 1{\cdot}4000) \times 1000 + (N^D_{45} - 1{\cdot}4440) \times 1000$$

T denotes titre and N^D_{45} the refractive index of the fatty acids at 45° C.

In the case of genuine ghee the value lies between 84 and 86 whatever be the Reichert. Any value above 86·5 indicates adulteration with a solid or semi-solid fat and in most cases, an addition of 10 per cent. of the adulterant can be detected. The new value detects adulteration of ghee not detected by any other available method.

The following are typical examples of a genuine and an adulterated ghee :—

		A	B
Reichert-Meissl	..	29·0	25·0
Titre of insoluble fatty acids ..	..	41·7	42·2
Refractive index of fatty acids at 45° C.	..	1·4440	1·4450
New Value ..	..	85·7	88·2
Conclusion ..	..	genuine	adulterated

The significance of the terms used in the formula and the experimental details will be dealt with fully in the detailed paper on the subject which will be published in a suitable journal.

V. VENKATACHALAM.

Corporation Laboratory,
Madras,
February 17, 1937.

A Noteworthy Feature in the Anatomy of *Cycas* Roots.

WHILE examining some sections of *Cycas* roots for class work, we find a number of ordinary roots showing a tetrach condition. It is formerly known that the coralloid roots are tetrach and the ordinary roots, diarch. The ordinary roots showing a tetrach condition found by us are absolutely devoid of any algal infection and are not tuberculate. This is contrary to the belief that only the coralloid roots are tetrach, the ordinary roots remaining diarch. It seems that the tetrach or diarch condition of the roots of *Cycas* is not dependent upon algal infection but upon the level of the roots in the soil, the roots at a deeper level showing a diarch condition and those near the surface showing a tetrach condition.

This point has been referred by one of us to Dr. Sahni of Lucknow and at his suggestion Mr. A. R. Rao of the same University seems to have taken sections of a two-inch long root of a very young *Cycas* plant and he also confirms our observation. I quote the following sentences from Mr. Rao's letter. "Sections from the region nearest to the surface of the soil show a tetrach condition while those from the more deeply buried apical part of the root show a diarch condition. The root was of course uninfected by alga. As you mention, it is possible that the diarch or tetrach condition of the root is not dependent upon algal infection but upon the level of the root in the soil."

In Engler's *Das Pflanzenreich* it is mentioned that the normal primary roots of *Cycas* are at first tetrach. But our observations clearly show that all the secondary roots also that are near the surface of the soil show a tetrach condition. It is not confined to the primary root. We took sections of even very small rootlets of a *Cycas* plant and found the tetrach condition in them. This phenomenon needs further investigation.

V. SITARAMA RAO.
N. N. MURTI.

Lingaraj College,
Belgaum,
March 4, 1937.

Sexual Maturity of Some Sedentary Organisms in the Madras Harbour.

IN a recent note in *Nature*,[1] J. M. Dodd and others from Liverpool record the sexual maturity of one-year old *Ostrea edulis* though there is a prevalent idea that they do not mature until they are three years old. At the suggestion of Professor R. Gopala Aiyar, extensive investigations on the rate of growth and the age at sexual maturity in a number of sedentary forms in the Madras Harbour have been carried out for the last 15 months as a result of which it has been found that in a number of forms, some of which are mentioned below, sexual maturity is attained at a surprisingly early age.

Regular observations have been made on animals growing on selected spots within the Harbour. Also suitably constructed wooden racks containing glass slides were immersed in different localities and the slides with the animals settled on them were brought at definite intervals to the Laboratory and detailed study of their size and condition of their gonad was made throughout the period.

The breeding period of several forms has also been worked out. A comparison of the conditions obtaining here with the recorded observations of the breeding period of various animals in the English coast, La Jolla (California), Woods Hole (Mass.) and in the Low Isles of the Great

Barrier Reef as recorded by Orton,[2] Coe,[3] Grave,[4] and Anne Stephenson,[5] respectively are of much interest.

The following table gives the age after attachment and the size at maturity of a few forms.

No.	Species	Age at maturity days	Maximum Size	
			Length mm.	Breadth mm.
1.	*Hydroides norvegica*	9	14·0	..
2.	*Balanus amphitrite*	16	8·8	7·3
3.	*Ostrea (Cucullata ?)*	21	12·5	12·0
4.	*Mytilus viridis* ..	48	15·5	9·4

A detailed account of this work will be published elsewhere.

My sincere thanks are due to Professor R. Gopala Aiyar, Director of the Laboratory, for his ready help and constant encouragement throughout this work.

M. D. PAUL.

University Zoological
Research Laboratory,
Triplicane, Madras.
March 5, 1937.

[1] Dodd, J. M., and others, *Nature*, Jan. 16, 1937, **139**, 108.

[2] Orton, J. H., *Journ. Mar. Biol. Assn.*, 1919-22, **12**.

[3] Coe, W. R., *Bull. Scripps Ins. of Ocean Calif.*, 1932, **3**, No. 3.

[4] Grave, B. H., *Biol. Bull.*, 1933, **65**.

[5] Stephenson Anne, *Scien. Rep.*, Great Barrier Reef Expedition, 1934, **3**, No. 9, Part II.

Chromosome Numbers in Some Economic Flowering Plants.

The chromosome numbers of several economic flowering plants have been examined in our laboratory. The following table gives the n and $2n$ countings of some species.

Species	Family	n	$2n$	Remarks
1. *Pongamia glabra* Vent.	Papilionaceæ	11	22	Reported for the first time.
2. *Arachis hypogæa* Linn.,				
(i) Var. Small Japan—a bunch variety	,,	20	40	The n number in this variety was reported by Badami, V. K., to be 10. *J. Mys Exp. U.*, **15**, 2-3. Husted, L., gave the $2n$ number of certain bunch varieties as 40 both in *Am. Nat.*, 1931, **65**, 700, 476, and in *Cytologia*, 1933, **5**, 109-117. The variety Small Japan crosses freely with the other known varieties of groundnut.
(ii) Var. Gudiyatham Bunch—a bunch variety	,,	20	40	
3. *Moringa pterygosperma* Gærtn.	Moringaceæ	14	..	Not known to have been reported previously.
4. *Sansevieria Roxburghiana* Schult. f. Bow-string Hemp.	Liliaceæ	20	40	Determined for the first time from a wild race.
5. *Phœnix farinifera* Roxb.	Palmaceæ	18*	36†	* Already reported in *Curr. Sci.*, 1936, **4**. † Reported for the first time.
6. *Amorphophallus companulatus* Bl. Elephant yam	Araceæ	..	28	Reported for the first time.

Oil Seeds Laboratory,
Agricultural Research Institute,
Coimbatore,
September 30, 1936.

J. S. PATEL.
G. V. NARAYANA.

Presence of Embryonic Respiratory Organs (External Gills ?) in *Acentrogobius viridipunctatus* (Day).

This fish is a brackish water form and occurs in fairly large numbers in Adyar. Eggs are laid in clusters and each egg is provided with an egg-case or capsule, club-shaped in appearance. During development a pair of embryonic respiratory organs are formed. These are found to develop during the late embryonic period from the base of the hyoidean arch and are partially united at the base. The anterior portion of the ventral aorta divides into the two hyoidean arteries which at this period are the largest of all aortic arches. Each hyoidean artery is continued into one of these structures as a vascular loop as in the case of true external gills. In section

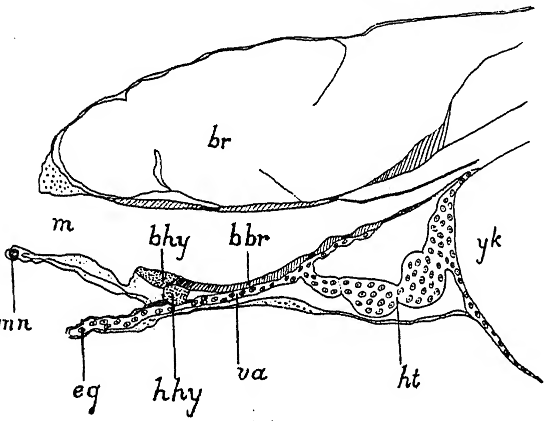


Fig. 1.

A Longitudinal median section of the head of a newly hatched larva passing through one of the external gills. × 120

bbr. Basibranchial; *bhy.* Basihyal (procartilage); *br.* Brain; *eg.* External Gill; *hhy.* Hypohyal (procartilage); *ht.* Heart; *m.* Mouth; *mn.* Mandibular; *va.* Ventral aorta; *yk.* Yolk.

the structure of these organs is the same as in a typical external gill. They are moved about occasionally. Embryos with poorly developed respiratory organs are found to be unhealthy and they seldom hatch out and even if they do so, none survive. Soon after the hatching of the larva the organs in question shrink suddenly and become non-functional. Blood supply into them is cut off and cross connections are effected between the ventral aorta and the hyoidean arteries, thus giving rise to a short circuit.[1] A little later the organs are gradually absorbed and are completely lost by the third day after hatching.

The position of these organs on the outside of a visceral arch, the continuation of the main aortic arch into them, their capacity to flick occasionally, their internal structure and their relation in sections to the visceral arch are all points in favour of considering them as true external gills.[2] Gill pinnæ are absent. The partially fused condition might be a secondary feature brought about by the close apposition of the two gills similar to that in *Lepidosiren*[3] where all the four gills on each side fuse together at the base during the late larval period. The rapid atrophy and the change in blood circulation are features strictly comparable to what takes place in the true external gills. A detailed account of the development, structure and degeneration of the organs will be published elsewhere.

True external gills are, as far as I am aware, unknown in Teleostei, though among the other fishes their presence has been noted in Crossopterygian Ganoids[4] and Dipnoids.[4,3] External gill filaments, which are mere elongations of the internal gill lamellæ[5] have been noted in the larvæ of Teleostomes and embryos of Elasmobranchs.

My thanks are due to Professor R. Gopala Aiyar, Director, University Zoological Research Laboratory, Madras, for his constant help and kind encouragement during the course of this work.

S. Jones.

Zoological Research Laboratory,
Madras,
February 23, 1937.

[1] Kerr, G., *Text-Book of Embryology*, II. London, 1919, p. 394.
[2] Kerr, G., *Ibid.*, p. 154.
[3] Kerr, G., *Phil. Trans. Roy. Soc., London*, (B), 1900, **192**, p. 317.
[4] Budgett, J. S., *Trans. Zool. Soc. Lond.*, 1901, **16**, pp. 115-136.
[5] Goodrich, E. S., *Structure and Development of Vertebrates*, London, 1930, p. 501.

Cement Glands (Adhesive Organs) of *Etroplus maculatus* (Bloch).

During a study of the development of some of the brackish-water fishes of Adyar, the origin, development and degeneration of the cement glands of *Etroplus maculatus* were worked out. These structures though known to be present in some tropical Teleosts like *Hyperopisus* and *Sarcodaces*,[1] *Etroplus*,[2,3] *Heterotis* and *Gymnarchus*[4] and *Pterophyllum*,[5] their origin has not been worked out in any of these forms.

In the Ganoids these glands are of endodermal origin though in the course of development they are pushed outside to occupy an ectodermal position.[6,7,8] In the Dipnoids they take their origin from the

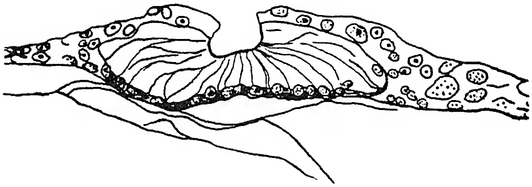


Fig. 1.

A median section through the cement gland of a larva of *Etroplus maculatus* on the fifth day after hatching. Degeneration has just set in. × 380.

inner layer of ectoderm[9,10] whereas in Anura they develop from the superficial layer of ectoderm.[11,12] In *E. maculatus* the glands are observed to develop from the inner layer of ectoderm as in Dipnoi. There are altogether three pairs, situated on the antero-dorsal side of the head. The arrangement, structure and function of the glands are the same in *E. suratensis* in which form also they have been observed. The glands in *E. maculatus* grow in size and remain functional till the fourth day after hatching, after which they degenerate rapidly and disappear by the seventh day. A detailed account will be published elsewhere.

I would like to express here my thanks to Professor R. Gopala Aiyar, Director, University Zoological Research Laboratory, for his valuable suggestions and kind encouragement during the course of this work.

S. JONES.

University Zoological Research
Laboratory, Madras,
February 23, 1937.

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[1] Budgett, J. S., *Trans. Zool. Soc. Lond.*, 1901, **16**, pp. 115–136.
[2] Willey, A., *Spol. Zey.*, 1911, **7**, p. 102.
[3] Sundara Raj, B., *Rec. Ind. Mus.*, 1916, **12**, p. 283.
[4]* Kerr, G., *Text-Book of Embryology*, II, London, 1919, p. 182.
[5] Lieberkind, I., *Zool. Anz.*, 1932, **97**, pp. 55–61.
[6] Phelps, J., *Science*, N. S., 1899, **9**, p. 336.
[7] Kerr, G., *Budgett Memorial Volume*, Cambridge, 1907, pp. 228–232.
[8]* Sawadsky, A. M., *Anat. Anz.*, 1911, **40**, pp. 356–378.
[9] Kerr, G., *Quart. Journ. Micr. Sci.*, 1902, **46**, p. 420.
[10]* Kerr, G., *Kiebels Normentaf. zur. Ent. Wirbeltiere, Jena*, 1909, **3**, pp. 1–31.
[11] Assheton, R., *Quart. Journ. Micr. Sci.*, 1896, **38**, p. 471.
[12] Bhaduri, J. L., *Trans. Roy. Soc., Edin.*, 1935, **58**, p. 339.
* As referred by Kerr, 1919.

A Case of Commensalism between a Gastropod and a Monascidian.

COMMENSALISM is the association of two living organisms as messmates with a view to mutual benefit or benefit to at least one of the associators. Nearly every group of animals has some forms which exhibit this phenomenon. The purpose of this article is primarily to place on record this type of an association between an ascidian and a gastropod mollusc and secondarily to discuss the nature of such an association. While collecting ascidians off Tuticorn, in the Gulf of Mannar, the author was struck by the fact that there is almost always a constant association between the gastropod *Turbinella pyrum* (the Sankha or sacred conch) and *Herdmania* (*Rhabdocynthia*) *pallida*, the common monascidian of the Indian seas. Appearing at first to be merely accidental, closer examination of the chank beds revealed that not only was the association more or less constant, but that a large number of the gastropods actually bore the ascidian on top of their shells. There appeared therefore a number of moving ascidians in the chank bed. A number of such specimens of *Herdmania* were examined and each animal was found attached to the *Turbinella* shell on its aboral side, on top of the body whorl. Both the gastropod and the ascidian were perfectly normal in every other way (Fig. 1).

It may be argued that some tadpoles of the ascidian get attached accidentally and develop later into adults. The frequency of the occurrence of such an association and the fact that only one ascidian has been observed attached to one gastropod, seems to give the lie to such a view. Moreover, quite large forms of the ascidian have been found attached to rather small young forms of the gastropod. This could hardly have been possible if the ascidian always got attached to the shell at the tadpole stage. Whether monascidians can re-attach themselves to a fresh surface once they are dislodged from their place of original (tadpole) attachment is a point which awaits investigation; but the foot of *Herdmania pallida* appears to be capable of acting as an adhesive organ under certain circumstances.

The advantages of this association to the ascidian are quite obvious. The ascidian benefits not only by obtaining more food and oxygen, as it is carried by the gastropod

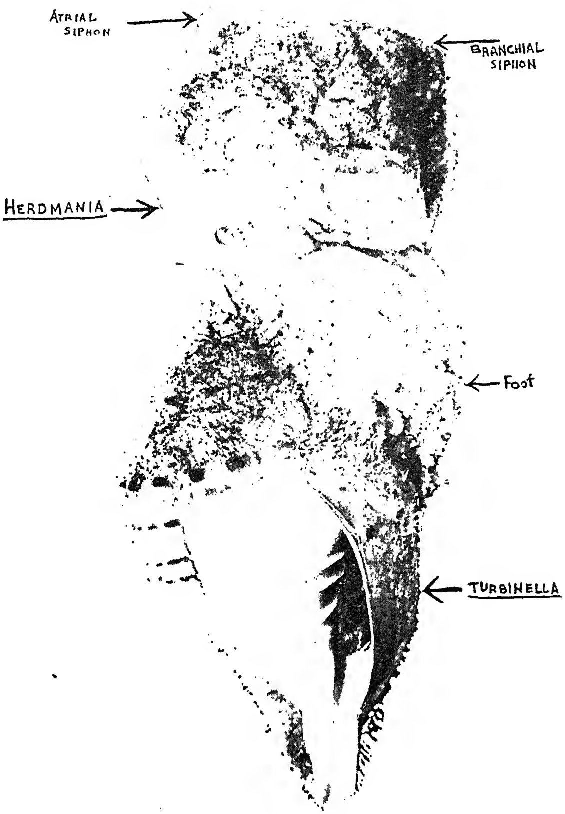

Fig. 1.

A Photograph of *Herdmania pallida* attached to a living *Turbinella pysum*.

from place to place over a large area, but is also able to disseminate its progeny over a wider range. Whether the mollusc gains any advantage is difficult to ascertain; but the large ascidian on top would certainly conceal it from the view of its enemies, if there were any. James Hornell, in his *Common Molluscs of South India* writes: "Finally, the pale yellowish-brown periostracum (of *Turbinella pyrum*) simulates closely in colouring to the sand and should be further protected against its discovery by enemies; to this form of protection I am, however, not inclined to assign great value, for chank divers can distinguish the presence of a chank even when half buried in the sand, and if they can, I feel assured that predatory fish are equally clever." Presuming that the intelligence of an Indian diver is the same as that of a fish (!!), this cleverness on the part of the fish would be of no use when the top of the chank is hidden from view by the ascidian and is the only part visible when (as is its habit) the chank is half imbedded in the sandy bed. In fact, the divers brought up the commensal forms not while looking for the chank but only when they were searching the ascidian. The ascidian itself is extremely unpalatable on account of the tough test and the spicules present in its tissues.

It may be mentioned here that, to my knowledge, this is the first time that a record of commensalism between a gastropod and a monascidian has been made. Both animals are typically Indian and it would be worth while to investigate the phenomenon in other Indian animals.

S. M. DAS.

Department of Zoology,
Lucknow University,
Feb. 23, 1937.

Mosquito-Destroying Fishes.

DR. SEN'S suggestive paper published in the January number of *Current Science* contains the following statement which I feel should not be allowed to pass without challenge. On p. 360 he says "The employment of fish which are not known to show a definite preference for Anopheline larvæ cannot therefore prove a success in controlling malaria in Lower Bengal". And his paper seems clearly to indicate that no such preference can be demonstrated from the stomach contents of four of the principal fish relied on as mosquito destroyers "collected from the various types of water-collections which are usually met with in the neighbourhood of Calcutta".

Though I have no practical knowledge of the malaria problem in Lower Bengal—nor, indeed, of anywhere else—and though, being concerned only with practical results I did not trouble to identify my fish very precisely, I think that the following observations that have now been continuing over a number of years clearly show that fish of the *Haplochilus* type do have a definite larvicidal value, Dr. Sen's observations on the stomach contents of *Panchax panchax* notwithstanding. The fish used have presumably been throughout either *Haplochilus melanostigma* or *Panchax parvus* or both, these being the fish of this type that are prevalent locally.[1] The Anopheline larvæ were presumably not those of malaria-carrying species as no such adults have

ever been found in the compound, where Anopheline adults are never very common and usually seem to be entirely absent.

In spite of the comparative rarity of adult Anophelines, no cement tank of clean water, such as exist in any compound can long remain free from their larvæ, though whether this is true for all seasons of the year I am not quite certain. For this reason I always try to keep the cement tank in my fernery—well shaded by a spreading Rain Tree—stocked with the local *Haplochilus*. In the absence of weed they soon disappear, picked out no doubt by Kingfishers or other birds; so I keep weed in it, which usually grows very thick. And if the surface of the water falls so far below the top of the vertical sides as to prevent the escape of any tortoise that may fall in, the fish also disappear in time. *Whenever the fish disappear, mosquito larvæ appear, though not a single specimen can ever be found so long as they are there.* When weed, dead leaves, etc., are present these may be Culicine, at least in part, but Anophelines are, I feel sure, the rule in fresh clean water. So completely do the fish keep down the larvæ that they must be presumed either to destroy every egg-laying adult or to destroy the larvæ at a very early stage—so much so that I think it would be surprising if any larval remains could be detected in their stomachs.

Within about a hundred yards of this small cement tank is a large tank dug into the ground, about 40 yds. square, and so deep that it is only after two successive years of drought that it has ever been known to go dry. This tank has, since it was last dry and cleaned out some years ago, been kept free from water weeds; but fine grass grows on its gently sloping banks, spreading down into shallow water, and in places leaves fall in from overhanging trees. This tank is stocked with the same fish, and I believe that they play an active part in keeping down mosquito larvæ in it. They do not, however, eradicate them completely, doubtless because the fish cannot penetrate freely among the grass stems and dead leaves in very shallow water, where alone the larvæ are found. Some time ago the fish disappeared completely from this tank also—exterminated there is good reason to believe by two or three ducks belonging to my cook—when it was interesting to note that mosquito larvæ still seemed to be confined to the shallow marginal areas; I regret that I made no exhaustive examination; so cannot be quite sure. My impression from memory is that they were somewhat, but not very much, more numerous than when fish are present, except during the rains in a flooded ditch through which water drains on the compound into one corner of the tank. This drain, in which I had often noticed shoals of the fish in previous years, was in their absence this year swarming with mosquito larvæ, both Anopheline and Culicine. It is now almost dry, but practically the same conditions remain at the corner of the tank which it joins. The tank now, however, is well stocked again with fish and a shoal of them haunt this corner which is practically free from mosquito larvæ.

From this it seems to me clear that fish of the *Haplochilus* type do assist in materially reducing mosquito larvæ and under suitable conditions establish a complete control of them, but that the extent of their utility is limited by any conditions that tend to impede their freedom of movement. It is also evident that in any examination of stomach contents the density of the larval population from among which the fish are taken needs to be carefully taken into consideration, and that this means not so much the population of the pools relatively to their size as the actual density of population in the areas readily accessible to the fish, which will be much less simple to determine. Dr. Sen is completely silent on this question; and in the absence of such information it seems to me, in the light of the observations recorded above, that his results do not necessarily lead to the conclusion he draws from them, but may instead be due to such complete control *in the areas accessible to the fish*, that the supply of larvæ actually available was insignificant.

Another obvious factor limiting the reliability of fish of the *Haplochilus* type in the control of mosquitoes is their liability to extermination by birds, and doubtless also by predaceous fish, as well as by drought; and the necessity for careful restocking whenever this occurs.

Museum House,
Egmore, Madras,
February 8, 1937.

F. H. Gravely.

See Sundara Raj, *Rec. Ind. Mus.*, 1916, p. 251.

REVIEWS.

A Hand-Book of Statistics—for use in Plant Breeding and Agricultural Problems. By F. J. F. Shaw, C.I.E., D.Sc., A.R.C.S., F.L.S. (Imperial Council of Agricultural Research, Delhi), 1936. Pp. 182. Price Rs. 4–6 or *7sh. 3d.*

A book of this kind has not been written before. It is so comprehensive in its practical scope and yet without a single bewildering passage. The author has shown a sympathetic understanding of the difficulties of those unfamiliar with the abstruse principles of statistics. The chief merit of the book lies in the thoroughly worked out illustrations of all the more common statistical principles advanced in recent times for interpreting experimental results, particularly in agricultural research. The general standpoint adopted is that it is possible for any one engaged in agricultural problems to apply statistical tests without a deep knowledge of the underlying principles.

From the determination of mean, standard deviation, etc., the author has covered in 11 chapters and 24 examples, the field up to the application of the analysis of co-variance to the yields of crops. Particularly illuminating are the chapters on complex and serial experiments and the analysis of co-variance; the examples are worked at length and with a clearness of procedure leaving nothing to be desired.

As is inevitable in all first editions, certain errors have crept in and the following are a few among them.

The comparison of independent samples as worked under Table XVIII (p. 61) should be omitted. Formula (25) is the correct one to employ and not formula (28).

It is mentioned that "The angular difference between the two lines of regression is inversely proportional to the strength of the correlation between the two quantities" (p. 70). Actually the angle is

$$\tan^{-1} \frac{\sigma_x \sigma_y}{\sigma_x^2 + \sigma_y^2} \left(\frac{1}{r} - r\right)$$

While the section on serial experiments (p. 123) is very instructive, the illustration is taken from an actual experiment in which "the size of the plot varied somewhat from year to year, and from locality to locality" (p. 125) and the plot values are then calculated on the basis of equal areas "to maintain uniformity". In a hand-book intended to help workers to design experiments on the right lines, it would have been far better if, even at the loss of realism, an hypothetical experiment with emphasis on the equal size of plots had been taken. In the same section, the sum of squares due to blocks is taken as though there are 5 blocks, whereas there are actually 30 blocks. Because, a block in Table XLVI is not identical in all the seasons and in the two localities in the sense that a variety is. The necessary correction should be made when using the book.

This is not a corrigenda. These are pointed out only that the book may be made the more perfect. The practical worth of the book far outweighs the slight imperfections in certain aspects. It is said that the author has not lived to see his book being used by many workers in the field of Statistics applied to Agriculture.

D. S. R.

Higher Algebra. By Barnard and Child. (Macmillan and Co., London), 1936. Pp. 585. Price *20sh.*

It is really some time since a good text-book of Algebra for Colleges was published in the English language. The only text-books (worth the name) existing at present are those by Crystal, Milne and Smith. The first one treats mainly of analysis and has outgrown its use. The latter two are more modern in their treatment. The work under review serves a long-felt need by students and teachers alike. The authors have indeed tried to be as up-to-date and logical as possible. They have also tried to make some parts of it useful for people who are mainly interested in the applications of algebra, *viz.*, actuaries, engineers, etc.

The book begins with the more elementary properties of integers as it ought to be the case with any modern text-book of algebra. The second chapter contains a clear exposition of the theory of irrationals and the third concerns with the elementary

properties of polynomials. The other parts of the book contain a good deal of the theory of equations, the theory of numbers, continued fractions, finite differences and probability. Some of the more commendable features of the book which were not treated well in the usual text-books are these: (1) complete treatment of the solution of linear equations, (2) simple and correct proofs of the inequality concerning the arithmetic and geometric mean, (3) a good elementary treatment of the primitive root of a number and allied topics.

There can be no doubt that the book can replace with advantage the existing text-book for the I (Hons.) course of our universities and can also be used (omitting some portions) as a text-book by the pass students also. The only thing that can possibly be said against it is that it is priced rather too heavily. The authors could very well have omitted all of their treatment of analysis (*i.e.*, the calculus) as the information contained in the book is available in English in other books; that would have reduced the bulk considerably and probably the cost also. The publishers announce an 'Advanced Algebra' by the same authors which will be awaited with interest.

K. V. I.

The Chemistry of the Colloidal State. By Dr. John C. Ware, SC.M., PH.D. (John Wiley and Sons, New York; Chapman and Hall, Ltd., Inc. London), 1936. Second edition. Pp. xvi + 334. Price 18*sh.* 6*d.*

Despite the enormous and the very rapidly growing volume of new data and compilations on the chemistry of the colloidal state, from the standpoint of the requirements of a fresher, a real need existed for a text-book with a proper combination of the exhaustive and the essential of the subject. Judged by this criterion Dr. Ware has achieved a real success by his book under review. Its scope is indicated by the following headings of the successive chapters: I. Units of a Colloidal Solution. II. Sedimentation. III. Interfacial Phenomena. IV. Adsorption. V, VI, VII. Turbidity, Colour and Motion in the Colloidal State. VIII. Electrical Character of Interfacial Phenomena. IX. Preparation of Substances in the Colloidal State. X. Precipitation, Stabilisation and Protection. XI. Water in Combination. XII. Viscosity and Plasticity. XIII, XIV, XV. Gels; Silica Gel and its uses; Soaps. XVI. Contact Catalysis. The historical method of treatment has been often replaced, with much advantage, by an analysis of the knowledge now accessible. The account of the basis and the wide applications of the Donnan Membrane equilibria, of the determinants of the optical properties of, especially of the occurrence of the colour effects in, colloids, discussion of industrial catalysis are both lucid and in line with the findings of the latest researches.

Unfortunately a few errors have crept into this otherwise excellent work. Thus for instance on p. 238, it is observed that "change of an oil-in-water emulsion to a water-in-oil emulsion is *not* brought about by a change in relative amounts of oil and water used (as beginners may suggest) but by the use of different stabilisers." The incomplete validity of this generalisation is shown by the results of Robertson (*Koll. Zeit.*, 1910, **7**, 7), Roon and Oesper (*Jour. Ind. Eng. Chem.*, 1917, **9**, 156), Clayton (*Symposium on Colloids, Faraday Soc.*, Oct. 1920), Bhatnagar (*J. Chem. Soc.*, 1920, **117**, 542), Sanyal and Joshi (*J. Phys. Chem.*, 1922, **26**, 481), and Joshi (*Koll. Zeit.*, 1923, **34**, 197, p. 280 and *Trans. Farad. Soc.*, 1925, **20**, 512) who have shown that the water-in-oil type emulsions can be formed by simply shaking large amounts of a viscous oil with (monovalent) soap solutions. The formation and the stability of these emulsions is dependent upon a low interfacial tension and the viscosity of the continuous medium. Except for creaming, (which is not considered instability and which occurs in every emulsion sooner or later being due principally to the difference in the specific gravity of the two phases) the oil-in-water and water-in-oil type emulsions can be prepared in a stable state *by a mere change in the volume-ratio-of the two phases* (*loc. cit.*) and have characteristic constants for their surface tension and viscosity (*loc. cit.*). These properties in fact can be employed for the detection of the '*reversal of type*' and are as characteristic as the conductivity, or the Briggs' dilution method described by the author, and perhaps simpler (*loc. cit.*). In the chapter on the precipitation of substances in the colloidal state we miss references to the classical work of Smoluchowski, Freundlich

and subsequent workers on the kinetics of coagulation. Since this is a branch which not only interests an average student of colloids by its differentiation from the progress of change in the molecular medii, the rather simple and vivid use of the technique of the kinetic theory, and especially since the coagulation kinetics represents a frontier of the science of colloids that has shown during recent years such a wide development both from an experimental and theoretical standpoint, that a fuller statenemt of the principal findings in this line might have been included with advantage.

These represent, however, but minor points on which opinions might differ legitimately and which in no way detract from the value of the book. A particularly welcome feature of the work, and one likely to be of a distinct advantage to the student is the description of numerous applications of colloids to industrial practice, study of the life phenomena, analytical, electro- and geochemistry with apt illustrations and stress on the experimental side of these branches of the subject. There is a very useful and lucid summary at the end of each chapter followed by a rather judicious selection of exercises and problems, which help greatly in bringing to focus the subject-matter of the chapter. The book is clearly the result of much thought and experience in the class room and is sure to prove an invaluable companion both to the teacher and a student of the colloid science.

S. S. JOSHI.

Intermediate Chemistry. By T. M. Lowry and A. C. Cavell. (Macmillan and Co., London), 1936. Pp. 876. Price 12*s.* 6*d.*

The most important feature of this book is its comprehensive plan, in the sense that the Intermediate student need not purchase any other text-book in chemistry, since this one covers all branches of the subject, inorganic, physical, analytical and organic chemistry. The book has been written from the standpoint of modern Periodic classification and the modern conception of valency. The preliminary chapters give a lucid account of atomic and molecular theories, the structure of matter (including radio-activity and artificial disintegration), the electronic theory of valency and the classification of elements. This portion of the book (Part I) may be read with profit even by senior students.

Parts II and III deal with systematic chemistry beginning with Zero group. The student is made familiar with the properties of "Typical Elements" from each group in Mendeleeff's Table, and only thereafter are the "Transitional Elements" (in the modern sense) taken up which receive theoretical treatment before systematic description. This departure from the usual procedure is definitely helpful to the student, since he can now understand and appreciate the relation and the difference between the A and B sub-groups of Mendeleef's Table.

Parts IV and V deal with Analytical and Physical Chemistry, the latter being an adaptation with little change of the well-known *Class-Book of Physical Chemistry* by Lowry and Sugden.

In the Organic Chemistry section (Part VI) new methods of preparation are given, but more important is the theoretical treatment. Even Lapworth's interpretation of the cyanhydrin reaction, Robinson's explanation of the contrast between the unsaturation of olefines and of ketones, and the Resonance Theory of valency binding find a place in the text. One wonders whether the immature student will not acquire an exaggerated respect for chemical theories to the prejudice of chemical facts.

The reviewer noticed one error in the electronic formula of the oxygen molecule on page 39. The oxides of chlorine mentioned on page 283 do not correspond with the oxyacids given against them. A much more logical account of the action of nitric acid on metals could have been given by taking into consideration the electromotive series of metals.

The diagrams and printing are excellent and in keeping with the best traditions of Macmillan and Company. The book is reasonably priced, and is provided with a water-proofed cover to withstand the ravages of the laboratory bench.

M. R. N.

The Renaissance of Physics. By Karl K. Darrow. (The MacMillan Company, New York), 1936. Pp. 306. Price 12*s.* 6*d.*

The epoch-making achievements of the modern physicist in the brief space of the last four or five years in the realm of transmutation of elements have been

announced in such rapid succession that the average lay person has been left both profoundly impressed and puzzled. We say puzzled because, transmutation after so many centuries of being impossibly hard, has proved to be rather easier than it seemed in the 1920's, when first it began to be achieved and understood. Already 75 per cent. of the known elements have given clear signs of vulnerability to transmutation processes and some of them can indeed change in more ways than one, so that one can speak now of a subject of "Nuclear Chemistry". Finally to cap all, even light has been transmitted into electricity and electricity back into light.

Dr. K. K. Darrow, Research Physicist, The Bell Telephone Laboratories, has narrated in this book in a literary style, the story of these achievements. His country has been the scene of several of them, and possesses colossal high voltage engines such as the electrostatic machine of Van de Graaff of the Massachusetts Institute of Technology, and the Cyclotron of Lawrence of the University of California. The first nine chapters covering 220 pages prepare the reader to appreciate the achievements of this "Renaissance" which are narrated in the remaining three chapters. We feel, however, that at the present time, when the general knowledge in science of the layman is at no mean level, thanks to the several popular books and press articles, the introductory chapters could have been briefer and less verbiose but provided with more diagrams, so that the march of events leading up to the crowning achievements could be more clearly followed. The latter portions of the book are illustrated with several excellent plates and photographs, while the get-up in general is very neat and aids comfortable reading. The book is perhaps a little over-priced for a lay public to whom it is evidently addressed. It is a valuable addition to the series of present-day popular books on modern science and scientific ideas.

M. A. G. RAU.

Laboratory Methods of Organic Chemistry. By L. Gattermann. (Macmillan and Co., London), 1937. Pp. XVI + 435. Price 18*sh*.

Since the 19th revised edition of Gattermann's *Laboratory Methods of Organic Chemistry* was brought out by Prof. Heinrich Wieland in 1925 the book has been familiar to the advanced students of chemistry almost throughout the world. The usefulness and importance of the book may be gauged to some extent from the fact that it has passed through as many as five editions in the course of the last ten years. In the present 24th edition several noteworthy changes have been introduced. The substitution of micro-, or semi-micro, methods of analysis—the so-called "meso-analytical methods" as the author names them—for the macro-methods described in the previous editions, is particularly welcome in view of the great importance attached now to micro-analysis in every laboratory, entailing as they do, a great saving of both material and time. The methods described relate to the determination of carbon, hydrogen and nitrogen, by a modification of Pregl's method in which electrical instead of gas heating is employed and the use of the heating mortar (lead peroxide) is dispensed with. The other interesting features of the new edition are the inclusion of improved methods for the quantitative determination of such typical groups as the methoxy-, ethoxy-, acetyl and benzoyl radicals, the description of the newly developed chromatographic methods of separation illustrated by the separation of chlorophyll '*a*' and chlorophyll '*b*' pigments from spinach leaves, and detailed experimental procedure for the ozonisation of unsaturated compounds, exemplified by the preparation of adipic aldehyde from cyclohexene. Apart from these changes and the omission of a few preparations, the arrangement of the matter remains virtually the same as in the previous edition.

The expositions of the theoretical principles underlying the various reactions described in the book are undoubtedly useful, but a pertinent criticism appears to be that these are too elaborate, and therefore, out of place in a practical hand-book.

B. B. DEY.

Laboratory Experiments in Physiological Chemistry. By Arthur K. Anderson. (Chapman & Hall, London; John Wiley & Sons, New York), 1936. Pp. 224. Price 7*s*. 6*d*.

The author has explained in the preface that the book is intended to be a laboratory

companion to his *Textbook of Essentials of Physiological Chemistry*. It is probably meant for a beginner as the subject has been considered more or less on a qualitative basis, dealing chiefly with the reactions of carbohydrates, fats, proteins and other simple substances of physiological significance. The introduction contains hints on the use of the balance and a general idea of the methods of volumetric analysis; this as well as the chapter on quantitative analysis (excepting for the description and working of the colorimeter) could safely be omitted, as all the information given therein may be assumed to be part of knowledge necessary for a student commencing a course of practical physiological chemistry. In the chapter on physical chemistry some fundamental ideas of osmotic pressure and related phenomena are given and a passing reference to the phenomenon of surface tension made. In view of the importance of hydrogen-ion concentration in bio-chemical work, some experiments for determining P_H values by electrical methods might have been included along with a note on the use of the quinhydrone electrode. The chapter on colloids is confined to the preparation and properties of some colloidal solutions. The determination of the iso-electric point of casein, if included, would be useful knowledge as it involves the calculation of H-ion concentrations. In the chapter on carbohydrates, the quantitative estimation of sugars is limited to the polarimetric method only; chemical methods have been completely omitted. No mention of oxidising enzymes is found in the chapter on enzymes. Experiments such as those on the diastatic activity of malt extract prepared by the student, or on testing the fermenting power of yeast or comparing the peroxidase activities of plant saps, etc., would be desirable. The chapter on proteins should include Van Slyke's method of determining amino-nitrogen. The remainder of the book deals with the analysis of food, of blood and of urine. This has been done fairly fully and should prove to be useful to the average student. The questions given at the end of each experiment, although of an elementary nature, are of value to the beginner and calculated to make his knowledge well-grounded.

B. B. DEY.

A Manual of Radiological Diagnosis. By Ivan C. C. Tchaperoff, M.A., M.D., D.M.R.E. (W. Heffer and Sons, Ltd., Cambridge), 1937. Price 21*sh*. net.

This is a handy manual, specially designed to suit the needs of students and general practitioners, and is a welcome departure from the usual run of Radiological books which cater only to the Specialist. The author has brought together a large number of beautiful radiograms which greatly facilitate a thorough study of the various affections of the human body. The descriptions of X-ray appearances in the common diseases are concise and to the point.

After a few technical considerations regarding stereoscopy and radiographic detail, the author goes on to a masterly discussion on the affections of bones and joints, occupying more than half the book. This subject is very ably dealt with and lesions are described under the sub-headings Site, Characteristic changes, and Differential diagnosis. Fortunately for the student, both rheumatoid and osteoarthritis are included under the term 'Chronic arthritis'; thus simplifying a classification which has baffled clinicians a great deal. The appearance and union of the epiphyses around the joints are also dealt with. The author still adheres to proper names such as Schlatter's disease and Kienbock's disease in connection with *Osteochondritis juvenilis*, though the modern tendency is to discard such names. In the section on the Chest, there are discussions on Mediastinal shadows and on lung-tissue changes on disease. There is no reference to epituberculosis, a condition which is diagnosed with certainty by means of X-Rays. The author has wisely refrained from attaching undue importance to measurement of the heart shadow, in view of 'the great difficulty in obtaining exactly comparable points on the heart shadow'. In the examination of the stomach and the duodenum, a study of the rugæ or the mucous folds has assumed an important place as a direct evidence of disease, but no reference has been made to it, presumably because such study is highly specialised and beyond the scope of the book. There are chapters on the gall bladder, urinary tract, female generative tract, and on myleography and ventriculography.

On the whole, the book is extremely

lucid, studded as it is with illustrative photographs from cover to cover and is bound to be very helpful in the interpretation of radiograms. In a short 'foreword' Dr. P. H. Mitchiner rightly says that, to his knowledge—"there is no similar publication at the disposal of the medical practitioner"—a statement with which every reader of the book will unhesitatingly and wholeheartedly agree.

P. R.

The Biological Control of Insects. By H. L. Sweetman. (Comstock Publishing Co., New York), 1936. Pp. 461. Price $3·75.

The biological method of controlling insect pests is assuming paramount importance in Economic Entomology. Several workers, *e.g.*, Thompson, Smith, etc., have published general accounts of particular aspects of this fascinating subject but still there was a need of a comprehensive work which has been fulfilled by the publication of *The Biological Control of Insects*.

A large number of terms is used in the discussions on this subject, and various authors without clearly defining them have implied different meanings for them according to their personal views. The author of the present work, however, has given at the outset the definitions of the terms used by him in the text. Incidentally, this standarisation has given new meanings to certain terms to which there may not be general agreement. For instance, among examples of typical predatism as distinguished from parasitism, the author includes the action of ticks and lice on rodents, the adult fleas on rats and of mosquitoes on man.

The work under review covers a very wide ground indeed. Though most enemies of insect pests have proved to be other insect species, the author has rightly devoted a chapter to each of the other groups of organisms which destroy insects, *e.g.*, bacteria, fungi, viruses, protozoa, worms, fishes, amphibia, birds, mammals, etc. Insects suffer from several bacterial, fungal and protozoan diseases, but the artificial inducement of such diseases to control insect pests have not yet proved practicable. On the other hand, toads, birds and some mammals seem to be very effective. Among insects, parasitic Hymenptera and Diptera are the most important enemies of their fellow brethern.

The book includes a very useful chapter on the relative importance of Parasites and Predators. Potent reasons are given which dispel the rather common belief that predators are not as useful as parasites. It is true that parasites have generally a much higher reproductive power than predators, but whereas a single parasite seldom kills more than one host, a large number of hosts may be consumed by an individual predator.

To ecological workers and those who have read Chapman's *Animal Ecology*, certain portions in the present book, such as those dealing with biotic potential and environmental resistance may seem dilations or even repetitions but for the sake of completeness, as a text-book ought to be, these pages are justified. But there are other subjects, such as the differential effects of environmental factors on a host and its parasite to which adequate space has not been devoted. No mention has been made of the work of Hefley (*Journal of Economic Entomology*, **21**, 213-221) on the differential effects of humidities on the Hawk moth *Protoparce quinquemaculatus* and its parasite, *Winthemia quadripustulata* and that of Payne (1933) on the differential effects of temperature on *Ephestia kuhniella* and its parasite *Microbracon hebetor*. These works are of great importance to students of biological control. Hefley showed that at the same temperature, *viz.*, 27°C. lower humidities favoured the host while higher humidities favoured its parasite. Likewise Payne reached the conclusion that higher temperatures were favourable for the parasite and the lower temperatures for the host. Reference may also be made to the recent work of Ahmad (*Journal of Animal Ecology*, **5**, 67–93) who has shown that while the reproductive potential of *Ephestia kuhniella* is markedly affected both by temperature and saturation deficiency, that of its parasite (*Nemeritis canascens*) is practically unaffected by any of these two factors.

In the last but one chapter the author has very adequately summarised the results of biological control experiments so far undertaken in all parts of the world and comes to the important conclusion

that this method of controlling pests is not the most important weapon of the Economic Entomologist and that in most cases he has to depend on insecticides. He points out that the insect pests which have been successfully controlled by means of parasites and predators are mostly of island and insular-like regions, *e.g.*, Hawaiian Islands, West Indies, Australia, Japan, etc. These conclusions are certainly not encouraging to entomologists in a country like India which has not the advantages of being an insular-like region and whose farmers cannot afford to use expensive insecticides for controlling pests.

The book is very well got up and is conspicuously free from errors and misprints. We congratulate the author on the production of this comprehensive work on a subject which is of great interest to both laymen and trained entomologists.

HEM SINGH PRUTHI.

The Analytical Geometry of Conic Sections. By B. B. Bagi (Dharwar). 1936. Pp. 248.

This book primarily intended for the Degree Examinations of the University of Bombay is by no means a stale imitation of standard text-books. It presents many interesting new examples on the subject, and new methods of work on several topics. The book bears ample testimony to the teaching ability and experience of the author, and is, in the reviewer's opinion, perhaps the best book of the Degree (Pass) standard, that has come out in recent years.

As a text-book—at any rate for colleges outside Bombay—the book is not free from criticism. The attachment of primary importance on oblique axes in the earlier chapters is not desirable ; in fact, it tends to destroy the very elegance and purpose of analytical geometry. Most of the results involving oblique axes could be relegated to a separate chapter, the other chapters using mainly rectangular axes. The author could effect improvements in this direction as well as in the arrangement of the subject-matter of the book, without blaming the syllabuses of study of the Bombay University. The treatment of asymptotes (§§ 7·4–7·42)—call it new, if you like—certainly lacks the simplicity and elegance of the method based on the idea of double contact.

C. N. S.

Two New Statistical Tables based upon Fisher's *t*. By M. Vaidyanathan, (Miscellaneous Bulletin No. 13 of the Imperial Council of Agricultural Research, Delhi), 1936. Pp. 14. Price As. 6 or 8*d*.

This bulletin has two statistical tables bound to be of much use to agricultural workers. As the Statistician in the Imperial Council of Agricultural Research, the author has met the foremost agricultural experimenters in this country and has found that they prefer to express the statistical significance of experimental results by "odds against" instead of by "probability". The first table meets this need. In the actual use of Fisher's *t*-table interpolation has to be employed to calculate the exact value of P for a given t and n, whereas this new Table I gives directly the "odds against".

Tables II–A and II–B give the theoretical number of replications necessary for a given S. D. and for a percentage difference to be measured. There are two graphic illustrations and two arithmetical examples explaining the use of the tables.

The author deserves to be thanked for the pains he has taken to provide agricultural workers with these helpful tables.

D. S. R.

Les Ondes Hertziennes et la Structure Moléculaire. I. Methode d' étude du Spectre hertzien. Pp. 38, Price 10 *francs*. II. Absorption et dispersion dans le spectre hertzien. Applications. Pp. 62, Price 15 *francs*. By R. Freymann. (Nos. 399 and 400 of the Actualités scientifiques et industrielles.) (Hermann et Cie, Paris), 1936.

As a result of the rapid progress made in the last thirty years, the methods of study of the properties of matter over the electromagnetic spectrum extending from X-rays to the infra-red, are in common use in several laboratories, and a considerable advance has been made in our knowledge of the structure of molecules. The region of the spectrum extending over the Hertzien waves, is however equally important, but the methods of study are difficult involving a number of measurements and a multiplicity of apparatus. Drude was one of the first to indicate as early as in 1895, the utility of these measurements, but it is only recently since the development of the modern types of

valves such as the magnetron, and the high frequency generating circuits that these studies have been taken up more widely. In addition, the theory of dielectrics developed by Debye, although not perfect, has helped considerably the progress made in these investigations.

In these two monographs, the present status of the subject has been broadly reviewed, and a number of references given to the original literature for more detailed information. The first part deals with the several methods of generating waves and applying them for the measurements. In the second, after a brief review of the theories, a summary of the experimental results is presented in such a manner as to draw the attention of the physicist, chemist, engineer and the biologist to the usefulness and interest in this growing field of work.

M. A. G.

Transmutations. (Part II of the *Proceedings of the International Conference on Nuclear Physics*, 1934; No. 341 of the Actualités scientifiques et industrielles.) (Hermann et Cie, Paris), 1936. Pp. 83. Price 18 *fr*.

This is a collection of abstracts of the papers read at the International Conference on Nuclear Physics held in 1934 at London and Cambridge, and of the discussions that took place on that occasion. The summaries of the papers give the essential facts in an easily intelligible manner and the discussions are illuminating. The collection lacks unity of thought and treatment as was inevitable but the defect could have been remedied by short connecting notes such as are to be found in the *Leipziger Vorträge*. There are a number of misprints and some names are mis-spelt as, *e.g.*, Waiscott, Frish, Hafstod, &c. There is a curious medley in the order of a few pages: what is marked p. 51 contains the matter which should have been on p. 52 and *vice versa*. The page marked 53 should come immediately after page 50. The appearance of the book, though belated, is welcome since the problems considered in it are still engaging the attention of the scientific world. The recommendations of the Units Committee given at the beginning of the book form a useful addition.

L' Effet Zeeman dans les Spectres de Bandes. Par René Fortrat. (No. 363 of the Actualités scientifiques et industrielles.) (Hermann et Cie, Paris), 1936. Pp. 40. Price 12 *fr*.

The book is a summary of the complicated phenomena met with in the Zeeman effect of band spectra, and is written by one who has made fundamental contributions to the subject of band spectra. The basic principles are explained and the fundamental formulæ are deduced but the more complicated results are merely quoted, mostly from Crawford's articles in the *Reviews of Modern Physics*. The vector model is employed throughout. References to sources of further information are given, and the brochure well serves the purpose of placing a summary of theoretical results before the experimenter. A plate showing the Zeeman effect of some bands of CO and OH enhances the value of the book. There are two mistakes in the equations on p. 8. The equation $\bar{\mu} = \Lambda\mu_0$ should be $\mu = \Lambda\mu_0$ and the next step $m = \Lambda \cos(J^*\Lambda) = \frac{\Lambda^2}{J^*}$ should read $m = \Lambda \cos(J^*\Lambda) = \frac{\Lambda^2}{J^*}$. The final result however is correct.

Electrotechnics, No. 9. April 1936. (The Electrical Engineering Society, The Indian Institute of Science, Bangalore, India), Pp. 226. Price Rs. 2.

Electrotechnics is the Journal of the Electrical Engineering Society of the Indian Instititute of Science, Bangalore, and the present number which is the ninth of the series not only maintains its usual high standard but represents an advance in its usefulness to the Electrical and Communications Engineer and the Industrialist interested in these branches of Engineering. It is divided into two parts, the first dealing with the activities of the Department of Electrical Technology of the Indian Institute of Science, Bangalore, and of the Electrical Engineering Society; part two is technical and contains informative articles of great value covering many aspects of electrical and communications Engineering. A noteworthy contribution is the article on "Engineering Organisation of Nationwide Broadcasting in India and Development of Indian Radio Industry" by Mr. K. Sreenivasan. It might be recalled that Mr. Sreenivasan had

contributed an article entitled "Development of Nationwide Radio Broadcasting in India" in *Electrotechnics*, No. 8 and *Current Science*, Vol. III, p. 396, which has received widespread attention. In the present article Mr. Sreenivasan puts forth a scheme for the Engineering Organisation of Indian Broadcasting and also considers the possibilities of the Radio Industry in India with a wealth of statistics and details. It would appear that too much emphasis has been laid on centralised control in his scheme and there is bound to be difference of opinion on this question. There is no doubt that business men are alive to the possibilities of developing the Radio Industry in India but there are difficulties to be overcome from a commercial aspect of the problem. Another noteworthy contribution which would interest the Electrical Engineer and the research student is the article on "Asynchronous Torque Characteristics of Salient Pole Machines" by Prof. K. Aston. In this article Prof. Aston describes a quick oscillographic method of finding the asynchronous torque characteristics of salient pole machines which involves less expenditure of time and money than previous methods. To the industrialist and industrially minded Engineer there are a number of informative articles such as "Possibilities of a Nitrogen Industry in India", "Manufacture of Distribution Transformers", "Development of Porcelain Insulators", "The Electrolytic Zinc Industry of Tasmania", etc. To the research worker and student, articles like "Heavisides Operators and Expansion Formula", "The Exact Predetermination of the Performance of a Polyphase Induction Motor", etc. are undoubtedly useful. Informative articles like "Power Factor Tariff", "Scale Formation in Boilers", "Diesel Plants and their use in India", "Electrical Shock and After," etc. add to the usefulness of the volume. Some details are given about the Flying Flea construction in Bangalore and no doubt more information would be welcome. The Editorial Board of Electrotechnics are to be congratulated for producing this useful volume which must be in the hands of every Electrical and Communications Engineer and Industrialist interested in the development of these industries.

T. S. R.

Bulletin of the Geological Institution of the University of Upsala. Vol. XXIII. (Upsala), 1932. Pp. 337 + XII plates and numerous text-figures.

This bulletin is financed by the Swedish State and is published once a year by the Upsala University under the editorship of Professor Carl Wiman. The volume under review contains seven articles of which four are in German and the rest in English.

The first article is an exhaustive study by Dr. Erik Wiman, of some Archæan rocks in the neighbourhood of Upsala, and of their geological position. This paper, which runs into 170 pages, is divided into six chapters. Chapter I contains a detailed petrographic description of the rocks of the area such as quartz porphyry, quartz-andesite, diorite, quartz-diorite porphyry, various types of granite, malchite and amphibolitic dykes. Chapter II deals with the metamorphic rocks occurring along the contact between the Upsala and Arnö granites. The rocks are chiefly various types of gneisses, schistose granites and skarns. Chapter III is a small but important section, where the author gives the results of his measurements of zircon and apatite pleochroic haloes. Dr. Wiman claims to be able to distinguish the Upsala from the Arnö granites by this method, as double haloes are present only in the latter. Chapter IV deals with mineralized fissures and the succession of fissure-filling in the volcanic, hypabyssal and plutonic rocks of the area. Chapter V describes certain structural features of the Upsala rocks such as fissures, joints and cleavage. Chapter VI with which the paper concludes, discusses several important problems such as the differentiation of the rocks of the region, the significance of pleochroic haloes, the nature of rock-metamorphism and the inferences that may be drawn by a study of xenolithic inclusions in the volcanic rocks. The paper is illustrated with three geological maps, numerous line diagrams and with photographs of rocks both in the field and under the microscope.

The second paper is a mineralogical note by E. Grip on an enstatite from the Hochgebirge at Västerbotten. The physical, chemical and optical properties of this mineral are given. This is followed by a brief description of the glacial geology of portions of Hälsingland (Sweden) by J. Öster. Prof. C. Wiman next contributes

a palæontological note on *Goniopholis kirtlandicus*, a new species from the Upper Chalk in New Mexico. The fifth article by E. Ingmar gives the preliminary results of the author's investigations on the ice-dammed lakes and the marine limit in the north of Västmanland and the south of Dalecaria in Sweden.

The sixth article is by E. Ljungner in German, on the Geology of the Patagonian Cordillera, especially in the neighbourhood of Lake Nahuel Huapi in the Argentine National Park below the forty-first parallel. The rock formations of the Granodiorite Series and those older and younger than this series are fully described. An interesting section is devoted to the geomorphology of the district in which the orography, glacier-formation, ice erosion and valley-formation are dealt with. The paper concludes with a summary of the probable pre-Pliocene history of the area.

The volume concludes with a very interesting petrogenetic study of the Breven dolerite dyke by T. Krokström. This dyke is a typical example of a composite type, varying from a highly olivine-bearing dolerite through various intermediate types to a pure alkalic granophyre. The dyke is about twenty miles in length with a width ranging from two furlongs to a mile. A detailed mineralogical and petrological description is given of the different types of rocks composing the dyke; this section is illustrated by numerous microphotographs. Seven analyses of these rock types show the variations in chemical composition; of these, four are new analyses made specially for this paper by Dr. N. Sahlbom. After a consideration of the petrological, chemical and geological data, the author considers that the parts of the Breven dyke now visible represent a section of intermediate depth through a fissure that has served as a channel for a series of extrusions belonging to the same volcanic cycle. The material brought up by the different eruptions most probably emanated from a common magma reservoir and the different types of lava are examples of the normal line of differentiation within that reservoir. Those lavas, in chronological order, had a composition corresponding to the following rocks: 1. Olivine dolerite, 2. Olivine-free dolerite, 3. Granophyre, and 4. Olivine dolerite. The granophyre when ascending is supposed to have effected a strong pneumatolytic action upon the olivine-free dolerite, which was thus largely altered into an amphibole-rich, biotite-bearing, somewhat alkalic intermediate rock, for which the name epidolerite has been suggested. The latest olivine-dolerite was extruded only in a rather restricted volume, and after the epoch of denudation that uncovered the more deep-seated equivalents of the rocks. C. S. PICHAMUTHU.

Polarisation Dielectrique. Applications à la chimie des théories modernes sur la structure des molécules. By G. Allard. (No. 365 of Actualités scientifiques et industrielles.) (Hermann et Cie, Paris), 1936. Pp. 26. Price 10 *fr.*

This is the second of a series of three contributions made to the Conferencés d' Actualités held at the Conservatoire national des Arts et Métiers, on the "Applications of modern theories of molecular structure in Chemistry". The author has treated the subject in a most general manner within the time and space allotted to him, and has successfully endeavoured to introduce the general reader to the essentials of Dielectric Polarisation technique in the elucidation of structure of molecules. In view however of the two excellent small monographs by by J. Errara on 'Le Moment Electrique en Chimie et en Physique' (Nos. 220 and 221), in the same series, one fails to appreciate the necessity for publishing the present lecture on the same subject here.

M. A. G.

Spectres de Vibration et Structure des Molécules Polyatomiques. Par M. Radu Titeica. (No. 334 of the Actualités scientifiques et industrielles.) (Hermann et Cie, Paris), 1936. Pp. 68. Price 18 *fr.*

In Part I of this book, the methods of classifying and calculating the vibration frequencies of polyatomic molecules due to Radakovic and Mecke are explained, the results being merely quoted. In Part II, the vibrations of typical structures such as linear and tetrahedral molecules are described in detail and each case is well illustrated by discussing the results obtained with a number of molecules of the type considered. There is an extensive bibliography at the end, both infra-red and Raman spectra being taken into account. The book will serve as an excellent summary of results, particularly of use to the experimental physicist.

Human Genetics and its Social Import.

[Holmes, S. J., *Human Genetics and its Social Import.* (McGraw-Hill Publishing Co., Ltd., London), 1936. Pp. 414. Price 21*sh.*]

PROFESSOR HOLMES is known to students of Eugenics for his extensive bibliography on this subject published in 1924. His long experience in compilation and abstract writing have borne fruit in this readable and concise account of most of the research results pertinent to human heredity and population problems. The book is exceptionally free from prejudice and propaganda, and the author has a sincere desire to dispel the apathy that exists towards this important branch of biology. It is evidently a text-book designed for the needs of American college instructors. Only two of the 25 chapters are over 20 pages long, so that each is a convenient assignment with thought-provoking questions and reading suggestions appended.

The subject-matter falls into three distinct parts: (1) Resumé of modern genetics (Chaps. 1–8); (2) Summary of data on Human Genetics (Chaps. 9–12); (3) Sociological aspects of human traits in relation to natural selection (Chaps. 13–25). The first part is admirably expounded with interesting figures and diagrams. The second part, the kernel of the book, is disappointingly brief, but is instructive, with several good pedigree diagrams and excellent outlines of the results of studies on dentical twins. The last part will enable eaders to adopt a more scientific attitude on several important sociological questions of universal scope.

Heredity is a subject about which there is much superstition as well as false and dangerous half-knowledge. This book will help to combat ignorance and dispel dread by its unbiassed presentation of our scanty knowledge of human heredity.

Some characters which we used to think were caused by a single pair of genes (Mendelian factors), such as brown and blue eyes and feeble-mindedness, are now known to be influenced by modifying factors. One of the most remarkable facts about human inheritance is that a trait which is dominant in one stock may be recessive in another. It is now recognised that the whole complement of genes works together, and that every gene is affected by all the others.

Only a few of the simplest sex-linked defects are given and their importance is not stressed. It is shown that the offspring of consanguineous unions frequently show recessive defects; but the author does not think that primitive men realised this when they instituted incest taboos.

The old controversy concerning nature and nurture is treated fairly, and the arguments of both sides are recorded. We know how to nullify or circumvent some hereditary disabilities through environmental factors, *e.g.*, cretinism, diabetes. With regard to insanity and cancer, as with tuberculosis, what is apparently inherited is a susceptibility, tendency or diathesis rather than the disease; the part played by the environment is of great importance. These conditions are no longer regarded as the inevitable fate in store for certain individuals, whatever their family histories. Inimical environmental conditions are usually requisite for the manifestations of insanity. Students of human genetics must have the scientific attitude and free themselves from religious and economic theories, as well as race prejudice, if their conclusions are to be valid. There are inherent limitations to improvements in every genus and likewise in every strain. That "the power of nature to increase intelligence is limited" is obvious, but we have as yet no conception of the full potentialities of human beings under a scientific régime. Discoveries in the fields of endocrinology, nutrition and applied psychology are appearing so rapidly that most of the work on delinquency, retarded children and criminology is out-of-date before it is completed.

The last half of the book deals more especially with human ecology in the United States and Europe. India may be able to learn from some of America's mistakes. It is feared that in the West the less intelligent portion of the population are now increasing much faster than the more gifted people. The author points out that this "dysgenic period of our biological history is only a temporary stage which will be passed through as the practice of birth control has completed its downward course

through the masses". Since it is impossible to prevent the people of the higher social groups from limiting births, it may be a duty to the race to disseminate this knowledge to the less privileged as soon as possible. Dr. Holmes believes that the tendency to preserve the weak and unfit under modern conditions is offset by the fact that in a complex modern society natural selection tends to weed out the weaker intellectual strains.

The chapter on Death-rates is full of interest. Some common misunderstandings of the statistical increase in average longevity are corrected. Part of this increase is spurious and results from the greater average age of the population which arises from the decline of the birth-rate. For reasons unstated the author does not consider it possible that the human life span can be extended much beyond "three score years and ten". The statistical decline of infant mortality in Western countries is partially due to birth control, for "the number of children kept from dying is far less than the number who have been kept from being born." On the whole the differential death-rate is judged to be eugenic and to eliminate the unfit. This holds true for the universally higher mortality rate among males than females throughout life. Human females are innately more fit whatever their mental capacity.

Because human biology must be judged largely from statistics it is a difficult subject and full of pitfalls. Dr. Holmes warns against the unquestioned worship of the statistical method, which is a present tendency, and shows some of the fallacies involved in apparent correlations, and other Shibboleths, due to the fact that "the causal relations involved do not all appear on the surface." He also points out the weakness of standard intelligence tests, none of which measures innate ability.

The chapters on the biological effects of war and of differential population growth unwittingly throw into high relief the menace of group pugnacity under modern conditions. Since the world in space-time relationships is now smaller than was France under the Romans, nationalism is a dangerous relic of barbarism. The author records the desire of militarists everywhere for a high birth-rate, and also the heterogeneous ethnic composition of all nations. He fails to account for the disappearance of anti-Semitism in Russia since the War and for its recrudescence in Germany. Provincial, as well as racial group loyalty is now a liability in the struggle for existence. The leaders of such groups are making every effort to prevent people from realising that aggressive nationalism is an obsolete system at enmity with the welfare of the human race.

Special consideration is given to the racial trends in the United States, where practically all races are represented. The relative superiority of one race over another is still non-proven, and there is no satisfactory means of evaluating the native abilities of different peoples. Inter-racial crossing is probably not dysgenic when the hybrid is under no social disability. Now that transportation is so easy, races are fusing everywhere.

Although the author is a zoologist, sociological aspects are stressed while physical anthropology is almost completely neglected. The few references to specific races are inexact or connote political groups. The people of India are called Hindus, while "Indian" is used to designate American aborigines. The expressions American, Caucasian, Jew, Nordic, Slav and White Race are used loosely and with uncertain significance. In the extensive bibliography, references to Russian work are entirely lacking.

The history of the eugenics movement and its efforts is given. As a keen eugenicist the author wishes to lessen the ignorance that is rife concerning genetics. He feels that an effort should be made to improve the race so that men shall not become progressively stupider and, presumably, exterminate each other. This book could be studied with profit by women's clubs, student and professional reading groups and by all who are interested in mankind. In Indian colleges it should arouse a practical interest in human traits and their inheritance in the unique endogamous groups of the country, as well as in the many inter-racial crosses.

EILEEN W. E. MACFARLANE.

Production of Aluminium in Bombay.

[Dr. M. S. Patel, *Possibility of Production of Aluminium in Bombay.* (Bulletin No. 10, Dept. of Industries, Bombay, 1936.)]

THIS official bulletin dealing with the various aspects of economic development of the bauxite deposit of the Tungar Hill appears to be an important contribution and is expected to be of much value to those interested in mineral industry of this country. The bauxite deposit referred to in this paper has recently been discovered by the author on the Tungar Hill, in the Thana Dt. within 30 miles from the city of Bombay. The deposit happens to be within 60 to 100 miles from the hydro-electric power stations of the Tata Group. The plateau covers an area of about 140 acres and bauxite occurs as a cap varying in thickness from 5 to 22 ft. From careful prospecting it has been estimated that about 750 thousand tons of high quality bauxite suitable for aluminium production are available. The average composition of the representative sample of bauxite obtained from this deposit according to the author gives alumina 55 to 59 per cent.; iron oxide (apparently ferric oxide) 5 to 11 per cent.; titania 2 to 7 per cent.; silica less than 1 per cent.; and loss on ignition 28 to 32 per cent. Bauxite was further examined and found capable of giving alumina suitable for reduction to metallic aluminium.

The authour has given a brief historical survey of the discovery of aluminium and the important uses of the metal.

A reference to the Aluminium Industry of the world as given by the author would show that many countries of the world are already extracting metallic aluminium from bauxites. Not many of these existing plants are so favourably situated as to have on the spot all the raw materials and requirements for the most efficient operation of aluminium industry. As certain places near Bombay are favourably situated with respect to the electric energy and bauxite deposit there is no reason why the question of aluminium extraction from the Tungar Hill deposit on a commercial scale should not be seriously considered. It is a pity that almost all the bauxite that is quarried is exported to foreign countries and not utilised in India.

Average import figures during the last 10 years show that about 4,300 tons of aluminium were imported annually into this country and there is reason to believe that with gradual increase in the use of metallic aluminium the demand for the metal will be on the rise in succeeding years.

Of the many methods of aluminium extraction from bauxite Dr. Patel considers the Bayer-Soderberg process to be the most suitable for the Tungar Hill bauxite deposit. The author has gone into the details of the different raw materials and has carefully calculated the cost of production. Due consideration has also been given to the important question of cheap and dependable supply of electrical power and the author considers that such electrical power is available from the existing power stations in Bombay at reasonably low cost. The suitable site has been suggested to be somewhere near Kalyan on the Ulhas River. The cost of an entire reduction plant in Bombay in normal times ought not to be more than Rs. 1,500 per ton per year. For a 3,000 ton plant, therefore, the cost of the entire plant would not be more than 45 to 50 lakhs of rupees. The total cost of production of 1 ton of aluminium ingot from the Thana bauxite is according to the author's calculations Rs. 872 to 978. With the refined and finished marketable products like aluminium sheets and circles the cost will increase to Rs. 1,047 to 1,153 per ton. The price of the imported aluminium sheets and circles per ton varies from Rs. 1,300 to 1,900 c.i.f. Indian port. When the duty and tariff charges are added the price per ton goes up to Rs. 1,538 at Bombay. These figures of the author at once give Rs. 385 to 491 as margin of profit per ton of aluminium sheets produced. The difference appears to be sufficiently high to enable the industry to stand the probable competition from abroad.

If a plant with a capacity of producing 3,000 tons of aluminuim per annum be erected and taking 750 thousand tons to be the author's estimated reserve of the bauxite deposit the life of the Tungar Hill property

alone will be about 60 years (4 tons of bauxite being necessary for production of 1 ton of aluminium).

Dr. Patel has collected much information in this bulletin and has made out a strong case for further investigating into the question of aluminium extraction in Bombay. It is suggested that he should give exhaustive details regarding the capital expenditure and should show the percentage of profit from the income. Such information will make the paper complete and more useful and will certainly create interest amongst the *bona-fide* financiers.

N. N. CHATTERJEE.

Indian Research in the Service of Indian Reconstruction.

THE Oriental Library of the Mysore State in India has sent to the Society for Anglo-German Cultural Relations in Halle a comprehensive work, richly illustrated, on the tribes and castes of Mysore. The chief compiler of the book is the well-known Indian Anthropologist, Professor Anantha Krishna Iyer, who in 1934 was in Halle as a guest of our Society. The fundamental importance of this work for the Indian problem has suggested the remarks which follow.

Some weeks ago the German press gave reports of a study tour that the Maharajah of Mysore made through Germany. This Indian prince is at the head of one of the largest states in India with a population of about 6 millions. As an enthusiastic patron of arts and sciences the Maharajah founded, some years ago, the National University of Mysore and invited to its teaching staff a large number of the most eminent Indian scholars. Though living in a palace of fabulous Eastern splendour, this prince is remarkable for his personal modesty and marked philosophical interests. His chief care and interest, however, are for the population of his State, which, as is characteristic of India generally, is composed of a large number of racial and religious elements. With the aim of ascertaining the various population groups of his State in their various characteristics and so to obtain as far as possible a correct view of their age-old traditions, and from this to strive towards the formation, (a very difficult task), of a truly national community, the Maharajah gave some years ago to the Indian scholar, Dewan Bahadur Nanjundayya the task of drawing up a comprehensive report, as true to facts as possible, of the population groups of Mysore, their origin, their racial characteristics, their groups and their customs. Death prevented this Indian scholar from carrying through to completion the work which he began. The task was hence handed over to the Indian Anthropologist Professor Anantha Krishna Iyer who for about 10 years with indefatigable zeal gave himself up to the research of South Indian population groups.

Professor Iyer comes of an old Brahmin family and belongs, therefore, to the highest Indian caste. As is well known, in Hindu society still prevails the caste system, *i.e.*, the hereditary divisions of population groups into distinct classes, each standing in a certain rank with respect to others and each possessing certain special privileges, certain special modes of life, each engaged in certain definite occupations. Professor Iyer's book in which he has now published the result of his long researches in Mysore shows us how this Brahmin has stepped out of the narrow confines of his caste traditions. In the service of a great Indian prince, who aspires for the foundation of a homogeneous social and political community, he has given us an accurate picture, without his own interpretations, without any misleading arrangement or classification, the biological, religious and social characte of each of the population groups of Mysore With what special love he has performed his work is seen, among other things, from the numerous pictures with which the book is illustrated. He has himself photographed for the most part the various tribal types, characteristic groups of people, scenes from the people's life, and landscapes, that render the book so sumptuous and beautiful. The author has sketched in alphabetical order the various tribes and castes of Mysore, their origin, religion, mode of life, food, social gradations and professions. He describes their clothing, their birth ceremonies,

wedding festivals and burial ceremonies and the regulations concerning inheritance and adoption. As Germans and Europeans, we see in the several chapters of this book an unexpected variety of interesting modes of life and popular customs. The Fuhrer, as was to be expected from his great culture in the recent meeting of the Nationalist Party at Nurnberg, referred to the narrow outlook of many of the people who study the people's life and exhorted them to wider outlook. A work like the present gains special importance for such a purpose for it affords very valuable glimpses in the popular customs and self-expressions of a foreign country.

A speciality of the ethnological work before us is that it contains besides the foreword of Professor Iyer a number of introductory chapters, in which a number of eminent European scholars, among whom Professor V. Eickstedt of Breslau, point to the importance of such a work from various points of view. The English scholar who appears among these, denotes the book as a result of a truly pioneer work, which he expects will spur on the Indian academic youth to well-directed research work in the service of their country. For, several foreign influences are operative to-day in India threatening to obliterate the many beautiful and old traditions of the country. Also, the rapid growth of super-prolific nature tends to cover up almost before one's eyes the nemerous architectural remains of old cultural epochs. So, let us hope that the students and scholars of India will not wait to follow the example put before them by Professor Iyer. A systematic research of Indian culture, which has originated frcm a large variety of population elements should be of great use in the formation and development of a new India; new India should be built on the foundation of its age-old, rooted in its own soil, traditions. Only through consciously directed work and research can the Indian Nationalist make India again alive and useful to the present and the future. The Indian has given to mankind a large store of practical wisdom, almost exclusively directed to the highest spiritual aims; in their references to this wisdom, British friends of India warn Indians of their excessive contempt of practical and material life. As is well known, the great conflict in India is that, on the one hand, the Indian wishes to make his country free from England and undertake himself the formation of his own national and social life; they hope thereby to eliminate injustices and inequalities imposed upon the country by an unsympathetic foreign Government. On the other hand, a fundamental trait of Indian thought and Indian ages-old culture is to despise material needs and material aims, because these come in the way of man's highest duty, which is the deepening of the soul and the communion with the spiritual. So, a truly Indian "Life-consciousness" results in the express contempt for the outward life of man, contempt for the endeavour to external organisation and improvement. It is from this fact that English dominion in India gains a certain amount of justification. The new national reconstruction of Indian life can then only be achieved when the young and revolutionary Indian supplements his traditional ideas by a sound "this worldliness".

From these considerations Professor Iyer's scientific work gains a special importance which we can hardly overemphasise. This Indian scholar, without breach of his Brahminical traditions, though still under the limitations of certain narrow caste prescriptions, has collected and made available to the public a mass of knowledge that will tend to valuable results in the formation of a new people's life in India. He has also thereby performed to satisfaction the task that was assigned to him by a Maharajah with a wide outlook on life and anxious to secure a progressive reconstruction of his State.

DR. LORE LIEBENAM.

OBITUARY.

Dewan Bahadur Dr. L. K. Ananthakrishna Iyer.

DEWAN BAHADUR DR. L. K. ANANTHAKRISHNA IYER, who died on the 26th February last in his native village of Lakshminarayanapuram, Palghat, at the age of 75, was one of a small band of distinguished Indians who did pioneer work on Indian anthropology. He was for several years the Curator of the Museum at Trichur and Superintendent of Ethnography of the Cochin State. His first important work on the Cochin Tribes and Castes was published in 1909 in two volumes which immediately attracted the attention of European and American scholars. He followed this up with his monograph on the Syrian Christians and was entrusted in 1924 with the task of completing and editing the great ethnographic survey of Mysore begun by the late Dewan Bahadur H. V. Nanjundayya in 1903. The large mass of materials on the 34 tribes and castes of Mysore collected by Dewan Bahadur Nanjundayya was carefully sifted and edited by Dr. Iyer who made also large additions and published the work in four sumptuous volumes.

Dr. Iyer's great reputation as an anthropologist led to his being invited by the late Sir Ashutosh Mukherjee to organise the Department of Anthropology in the Calcutta University of which he remained the Senior Lecturer and Head of the Department till his retirement in 1932. During his tenure in the Calcutta University he successfully conducted several field trips with advanced students of anthropology and published many important papers on the social and religious institutions of the peoples of India.

Dr. Iyer visited Europe in 1934 when he was given the degree of Hon. Doc. of Medicine of the Breslau University and was elected as an Honorary Member of the International Congress of Anthropology and also one of the Vice-Chairmen of the Sections on Ethnography and Sociology. During this trip Dr. Iyer visited Italy, France and Germany besides England and delivered several lectures before learned societies in these countries. After his return from Europe, he was associated with Prof. Cipriani of Italy in carrying out importnat anthropological investigations among the Coorgs.

Dr. Iyer was a Corresponding Member of the Royal Anthropological Institute of Great Britain and Ireland, the American Bureau of Ethnology and the Anthropological Societies of Florence and Vienna. He was also a Foundation Fellow of the National Institute of Sciences of India, the Indian Academy of Sciences of Bangalore and Vice-President of the newly founded Indian Institute of Anthropology.

In his private life the late Dewan Bahadur was very amiable and charming in his manners and his habits were those of a simple orthodox Brahmin.

By his death India has lost a distinguished Indian who made important contributions to our knowledge of the habits and customs of the primitive tribes of India and on some of which he was the acknowledged authority.

B. S. G.

CENTENARIES

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Chamberlain, William Isaac (1837-1920)

W. I. CHAMBERLAIN, an American agriculturist of repute, was born in Sharon on the 11th February 1837. Having graduated in 1859 with honours in classics, he immediately became Instructor in Latin and Greek in his own college, *viz.*, Western Reserve College.

Turns to Agriculture

Six years later, his health and the need of his parents made it advisable for him to give up teaching and take over the home farm. His subsequent contribution to the science and craft of agriculture should be a source of inspiration for many a university man of our land to-day who is under the obsession that farming is incompatible with a university degree. To the art of farming, he applied the scholarly habits of a university man, reading and testing by experiments whatever scientific facts might find practical application in the management of soils and crops.

His Contributions

These tests and experiments formed the basis of his frequent contributions to agricultural journals. His knowledge of agriculture secured for him the Secretaryship of Agriculture of the State of Ohio from 1880 to 1886. During this time, he helped the organisation of a state-wide system of farmers' institutes and monthly crop reports. After being President of the Iowa Agricultural College for four years, he reverted to his original work of agricultural experiments and agricultural journalism. He was Associate Editor of the *Ohio farmer* (1891–1908) and of the *National stockman and farmer* (1908–1918). In 1891, he published *Tile drainage*, as a handbook for the use of farmers.

He died on June 30, 1920.

Colebrooke, Henry Thomas (1765-1837)

H. T. COLEBROOKE, the founder of the Royal Asiatic Society of Great Britain and Ireland and one of the pioneer orientalists, was born in London on June 15, 1765. His father was a prominent Director, and for some time Chairman, of the East India Company. Henry was never sent to a school. His studies were pursued at his father's house under a tutor and with such success that at the age of fifteen he had attained a considerable mastery of several classical and modern languages and had laid the foundation of profound mathematical attainments. His father's former connections with the East India Company secured for Henry a writership in the Bengal Civil Service with effect from 1783. After a tedious voyage, he arrived at Madras on April 8, 1783, and after a week's break, he again sailed for Calcutta. After a career of about thirty years, at the end of which he was member of the Supreme Council of India, he left for his native land in 1814.

Contributions to Science

While Colebrooke's major contributions were in the field of Sanskrit literature and Hindu law, we are here interested only in his contributions to science and this was not inconsiderable. The Royal Society's *Index* lists as many as twenty papers of his, three of which appeared in the *Transactions* of the Linnean Society and four in the *Quarterly journal of science* and one in the *Transactions* of the Geological Society. These papers belong to the later period of his life when he was settled in England. At this period, he is said to have fitted up a laboratory in one of his apartments, and his standing in the scientific world was such that he became the second President of the Astronomical Society in 1822.

Indian Algebra

His chief contributions to Mathematics and Astronomy were on the historical side, with special reference to India. On December 10, 1786, he writes to his father furnishing

him "with observations on the Hindu divisions of time, which are interest.ng in themselves and will show the precision of their astronomical knowledge in remote antiquity." The desire to acquire some knowledge of the ancient mathematics of the Hindus was the first stimulant to his acquisition of a knowledge of Sanskrit, although after some progress in that language, his studies took a wider range. His *Algebra, with arithmetic and mensuration, from the Sanskrit of Brahmagupta and Bhaskara, preceded by a dissertation on the state of the Science as known to the Hindus* was published in 1817. In the dissertation, Colebrooke contended that the Algebra of Europe was of Indian origin.

Indian Astronomy

He appears to have contemplated a work on Indian Astronomy similar in plan to his volume on Indian Al ebra. With this in view, he had commenced the translation of *Surya siddhanta*, the *Siddhanta siromani*, and the *Brahmasphuta siddhanta*. The translations are each accompanied with copious notes, in which he quotes from Indian commentators. He had further thrown together some extracts from works descriptive of the astronomical instruments in use in ancient India. He had also translated the astronomical calendar annexed to the *Vedas*. While several of his published papers deal with different aspects of Indian Astronomy and contain translations of portions of the mathematical classics, mentioned above, the comprehensive treatise, planned and written out by him, was not published.

His Honours

His interest in the cultural and the scientific history of the East led him to found the Royal Asiatic Society of Great Britain and Ireland in 1823. He was its Director from the year of foundation till his death. He was President of the Asiatic Society of Bengal from 1807 to 1815. He was also a Fellow of the Royal Societies of London and Edinburgh and of the Astronomical, Geological, Linnean and Zoological Societies and a number of several foreign academies. The *Centenary review* of the Asiatic Society of Bengal characterises him as "A great mathematician, zealous astronomer, and profound Sanskrit scholar who wrote nothing that did not at once command the highest attention from the public and, .. whose papers are still looked upon as models of their kind."

His End

He had much to harass him in his later years. His property proved unremunerative. Two of his sons died. Cataract reduced him to total blindness. He bore them all with fortitude and resignation until, as the after-effect of a severe attack of influenza, he died on the 10th of March, 1837.

Lafont, Eugene (1837-1908)

EUGENE LAFONT, an Indo-Belgian science teacher, was born at Mons, Belgium, on March 26, 1837. Having received his education at St. Barbara's College, Ghent, and at the Jesuit's seminary, he was admitted to the Society of Jesus in 1854 and was teacher in Belgium, till 1865. He was then appointed on the staff of St. Xavier's College, Calcutta, which had been founded by the Jesuit fathers in 1860 for the European and Eurasian community. In 1873, he became Rector of the College and remained as such till his retirement in 1904.

Father of Science in Bengal

On Lafont's arrival, Indian education was almost exclusively literary and Lafont was the pioneer of scientific education in Bengal. He equipped his College with a meteorolgical and solar observatory and with a physical laboratory. He lived in and for the physical laboratory. Popularisation of experimental science in Bengal was his chief life-work and he was an able teacher.

Indian Association for the Cultivation of Science

By his influence with Rajahs and other men of wealth, he obtained several endowments for the purchase of scientific apparatus. It was to a considerable extent owing to his influence that Mahendra Lal Sirkar founded the Indian Association for the Cultivation of Science in Calcutta in 1878. For about twenty years, Lafont gave weekly lectures under its auspices and was its Senior Vice-President. Readers of *Current science* know the great part that this Association has played in the furtherance of seientific research in India.

His Honours

As the rector of an important college, Lafont was a prominent figure practically in all the bodies of the University of Calcutta. At the jubilee celebrations of the University in March, 1908, he received the honorary degree of D.Sc. Even earlier, in recognition of his services to science he was decorated in 1880 with C.I.E. and with *Officer de l'Academie de France*. In 1898, King Leopold of Belgium made him a Knight of the Order of Leopold.

He died at Darjeeling on May 10, 1908, at the age of 71.

Proctor, Richard Anthony (1837-1888)

R. A. PROCTOR, astronomer and prolific writer, was born in Chelsea on March 23, 1837. His father's death in 1850 and his own delicate health interfered with his education and he was placed as a clerk in the London and Joint Stock Bank in 1854. However, as soon as the circumstances of the family improved, he entered the London University in 1855 and St. John's College, Cambridge, in 1856. His mother's death and his own marriage in 1858 led him to a low place in the degree examination in 1860. He next read for the bar, but in 1863 abandoned law for science.

He chose astronomy for his field of study and planned to write monographs on each planet. The first monograph, which was on *Saturn and his system*, came out in 1865. Recognised immediately in the scientific world as the work of a writer of consummate ability, it yet proved, in his own words, "commercially a dismal failure". The ruin of his finances by the failure of his bank led him to become a paid contributor to popular science journals. How irksome he found this unceasing drudgery may be gathered from his declaration that he "would willingly have turned stone-breaking or any other form of hard and honest, but unscientific labour, if a modest competence in any such direction had been offered him". His *Handbook of stars* (1868) was refused by Longmans and Macmillan. His *Half-hours with the telescope* which reached its twentieth edition in twenty years brought him only a fee of twenty-five guineas, when it was first issued in 1868.

His Contributions

Proctor was a prolific writer. In his thirty years of active scientific life, he published as many as 57 books, and contributed 117 papers to scientific journals. His last paper entitled *Note on Mars* was sent just before his death and his unfinished work *New and old astronomy* was completed by Arthur Cowper Ranyard and published in 1892. He also founded a popular scientific journal called *Knowledge*. His major contributions relate to the rotation period of Mars, the resisting medium in solar surroundings, the transit of Venus and his copying of the 324,198 stars of Argelander's *Survey of the northern heavens* on an isographic projection chart.

As a Popular Lecturer

His success on the lecturing platform was from the first assured and it greaty increased his popularity. In the words of Sir Robert Ball "Proctor....was a very popular Gilchrist lecturer. I heard him two or three times in Dublin, where he came in response to the invitation of the Royal Dublin Society. He possessed considerable literary power, and his lectures which were delivered in admirable language were frequently adorned by apt poetical recitation". On Proctor going out on a world lecturing tour in 1873, Sir Robert Ball himself succeeded him as Gilchrist lecturer.

His Last Years

On his return from his second lecture tour after the death of his wife, he married an American widow in 1881 and settled at St. Joseph, Missouri. He spent his remaining years in America. In September 1888, he was summoned on business to England. When he reached New York, he died of Malaria in the Willard Park Hospital on September 12, 1888.

Insects and Disease.

By Dr. S. M. Das, D.Sc.
(Lucknow University.)

FROM the earliest of times insects have had an evil reputation so far as they are an annoyance or direct menace to man, or his flocks and herds or are injurious to his crops. But it is only within the last thirty years that there has sprung into prominence the knowledge that, in another and more insidious manner, they may be the enemy of mankind, that they may be among the most important of the disseminators of disease. In this brief period such knowledge has completely revolutionised our methods of control of such diseases, and has become an important weapon in the fight for the conservation of health.

It is interesting to trace the development of our scientific knowledge of this aspect of disease. Mercurialis (1530–1607), an Italian physician, was one of the earliest to point out the relation between insects and disease when he wrote that flies acted as transmitters of plague which was then raging in Europe. Mercurialis had no conception of the animate nature of contagion, and his statement was little more than a lucky guess. It was left for Kirchir (1658) to definitely attribute the production of disease to living organisms, and there is no doubt that he had seen the larger species of bacteria long before Leeuwenhook's discovery of micro-organisms. It took more than two centuries to accumulate the facts to prove this hypothesis. Nothing remarkable was achieved in the eighteenth century; but in the next century, Nott (1848) was the first to attribute the cause of yellow fever to some form of insect life. Beauperthy (1853) stated more explicitly that yellow fever and some other fevers are transmitted by mosquitoes; and it is Dr. Beauperthy whom we must regard as the father of the doctrine of insect-borne disease. It is, however, after the epoch-making discoveries of Manson (1879) that we enter the modern phase of the study of insects and disease. Manson clearly demonstrated the transmission of *Filaria* (a nematode worm), by *Culex fatigans* (a mosquitoe), though it is now known that a number of species of mosquitoes, both anophiline and culicine, may serve equally well. Indeed, since the series of brilliant discoveries by Manson, in 1879, the present tendency is to veer to the other extreme and regard them all as vested with lethal powers over man and beast. It is a great pleasure to mention here that the malaria problem was solved for the first time in India (Ross, 1897), though the disease is quite common on the Roman Campagna and elsewhere.

The real cause of disease lies in parasitism. A *parasite* really means one that takes what it can from another (the host) regardless of any annoyance or any injury that it may accidentally inflict, but not to gratify any imperative predatory instinct. In short, there is benefit of one, the parasite, to the detriment of the other, the host. Parasites are of two main types; those that dwell within the body of the host, called *endoparasites*, and those that settle on the body of the host either temporarily or permanently—the *ectoparasites*. Most of the diseases are caused by endoparasites, while the ectoparasites act as transmitters of the disease from one form to another. It is interesting to note that most of the diseases caused by micro-organisms other than animal endoparasites are contagious, while those caused by animal endoparasites are infectious but not contagious.

Insects, that are lethal or pathogenic to man and other vertebrates, are generally ectoparasitic. Because of their peculiar mode of life they are responsible for the transmission of disease in man and other animals. Thus, biting lice (Mallophaga) attack birds, the sucking lice (Pediculidæ) infest mammals and the flea (Siphonaptera) too attacks mammals. But the group of insects that is the most pathogenic ectoparasite of all, and is responsible for the transmission of most of the terrible diseases, is the Diptera. Flies and mosquitoes are the chief amongst these. It must be kept in mind, however, that the real producers of disease are mostly the small micro-organisms that are the endoparasites of the host; and the ectoparasitic insects are related to the disease inasmuch as they only cause the endoparasites to spread from one host to another. Malaria is neither caused by stale gas nor by the bite of the *Anopheles* mosquito, but it is caused by a protozon called *Plasmodium*. Nor can cholera or dysentery arise from the presence of the house-fly, if the bacteria concerned were absent. The much feared Tse-Tse fly would be and is absolutely harmless—except for a little vexation on the part of the host—in the absence of another protozoon endoparasite in vertebrates called *Trypanosoma*.

On the other hand, many insects do cause disease directly in man and other vertebrates. The gad-flies inflict fatal injury to horses and cattle, the maggots of a bot-fly grow in the fronta' sinuses of sheep causing vertigo or even deatl and another bot-fly maggot develops in t stomach of horse, enfeebling the animal ve much. Myiasis is the name given to the disease caused by these dipterous maggots. Man is also subject to the attack of some of these maggots, and if the patient is left untreated maggots may enter the brain causing the death of the host.

We can, therefore, study insects in relation to disease in two different classes. The species, that, whatever else they may do, exert some direct effect upon the tissues of man; and the species that, whatever other direct effect they may produce, affect the organism indirectly, by introducing other germs or endoparasites. These two classes may be called the '*Insect parasites*' and the '*Insect carriers*' respectively.

The most important disease caused by insect parasites directly is Myiasis. Myiasis in man can be caused in one of five different ways. (1) The larva sucks blood through punctures in the skin: the only example known of this is the 'Congo floor-maggot' (*Auchmeromyia luteola*) which is found in crevices in the floor of huts. The maggot does not cause serious disease though sores may sometimes result. (2) The eggs are deposited in the natural cavities of the body: the screw-worm

fly (*Chrysomyia macellaria*) is the form which is mostly lethal. The adult fly deposits eggs in the nose, ears, etc. of persons sleeping in open air, specially if offensive discharges are present. The larvæ then burrow into the tissues, devouring the mucous membrane and underlying tissues, including muscles, cartilages, peritoneum and even bones, producing terrible sores thereby. If the patient is left untreated the maggots may penetrate the brain and cause death. The larvæ of *Fannia canicularis* often attack the urinary tracts in dirty people in this manner. (3) Eggs are deposited in neglected wounds: a good example of this in India is *Sarcophaga*, the larvæ of which burrow beneath the wound and migrate into the surrounding tissues causing extensive and terrible sores. (4) There are larvæ that live in the subcutaneous tissues causing tumours and ulcers in the body of the host: an example of this is the 'tumbu-fly disease' which is caused by the tumbu-fly (*Cordylobia anthropophaga*). The eggs are laid on the floor of huts and the larvæ enter the skin of the person sleeping on the ground, causing a painful boil-like local swelling. On the other hand, *Hypoderma* larvæ migrate from one spot to another and an ulcer on the arm may disappear one day only to reappear say on the chest next morning. (5) Lastly, some larvæ pass through the alimentary canal of the host and cause what is known as intestinal myiasis. Their presence in the stomach causes nausea, vertigo and violent fits; if in the intestines, the man may suffer from diarrhœa, abdominal pains and hæmorrhage. The larva of the fly *Fannia* may be ingested with decaying fruit where it lays its eggs. The larvæ of the bot-fly (*Gastrophilus equi*) are quite common in horses.

But, by far the most common way in which insects cause disease in man is by carrying the disease from an infected person to an uninfected one. Insect *carriers* may be (1) accidental or casual carriers, (2) the qualified or *adapted carriers* and (3) the *porters* that are intermediate between casual and adapted carriers.

Amongst the accidental carriers the foremost are the non-bloodsucking flies like the house-fly, which may spread abroad mechanically any pathogenic organism of any particular species. But any omnivorous domestic insect (cockroaches, ants, etc.) may serve as carriers of this kind. The ways in which the house-fly transmits disease are so well-known that flies and disease have become almost synonymous. The vomit-spots and fœcal-spots of flies form the most effective sources of fresh infection. A single regurgitation (vomit) means the deposition of thousands of micro-parasites; while in passing through the intestines, the micro-organisms may multiply and be deposited in far greater numbers with the fœcal matter than originally acquired by the fly through the mouth. The commonest flies found round about houses in India are *Musca domestica*, *Musca nebulo* and *Musca ententia*, as also *Calliphora erythrocephla*. Some of the diseases carried by flies are by far the most dangerous and widespread epidemics of all. Typhoid or enteric, dysentery, paratyphoid, summer diarrhœa, cholera, tuberculosis, anthrax, diphtheria, ophthalmia, infantile paralysis, small pox, tropical sore, yaws are all known to spread through flies.

The qualified or adapted carriers are insects that act as intermediate hosts of some micro-parasite, the life-history of which cannot be completed without the intervention of the insect; and since a part of the life-cycle of the micro-parasite is passed in the insect the presence of the insect is essential for the continuance of the disease. Malaria is by far the most important and widespread of the diseases caused in this manner. The role of the mosquito as the intermediate host of the malaria organism was discovered by Manson and Ross and has been confirmed by many medical men. But it should be remembered that it is only a single genus of mosquito (*Anopheles*) that transmits malaria, and, besides, only the females of the species that act as carriers, the males possessing no piercing mouth parts to puncture the skin and suck blood. Again, the bite of an *Anopheles* is not necessarily injurious, unless the insect has had previous access to malaria patients. *Anopheles* may be present where there is no malaria, but it has been found impossible to prove that malaria exists where there is no *Anopheles*.

Some of the other important diseases caused by adapted carriers are Yellow fever, Verruga, Sleeping-sickness, Filariasis, Typhus, Relapsing fever and Trench fever. At one time Yellow fever was a much dreaded scourge, specially in America; but it is now within human control. The history of the campaign against Yellow fever forms a classic example of the control of a serious disease by breaking the continuity of the life-cycle of the causative micro-parasite, by preventing the adapted carrier from transmitting the disease. The experiments that determined the mosquito-transmission theory definitely, are instructive as well as interesting. In a building, mosquito-proof but ill-ventilated, with bedding and clothes of Yellow fever patients, volunteers slept for many nights together, but their health remained unimpaired. Then a room was partitioned by netting, one part of which had infected mosquitoes and the other none. Two men were made to sleep in the two chambers, with the result that the one with the mosquitoes got the fever while the other did not. But directly the latter was transferred to the other chamber, he acquired the disease. Here, again, the mosquitoes concerned are confined to a single genus, *Stegomyia*, which is known as the 'house mosquito' on account of its domestic habits.

Verruga or Phlebotomas fever is transmitted by the *Phlebotomas* fly, though sometimes ticks may also be held responsible for its transmission. Trypanosomyiasis or Sleeping-sickness is one of the most dreaded diseases of central Africa, killing 50,000 natives every year. It is extremely fatal, mortality being placed at a 100%. The causative organism is a *Trypanosome* (Protozoon) which is transmitted by *Glossina palpalis*—the much dreaded Tse-Tse fly. Filariasis is caused by a Nematode, *Filaria* (*Wuchereria*) *bancrofti*, the larvæ of which swarm in large numbers at night in the peripheral circulation of the patient from where they are taken into the alimentary canal of a blood-sucking mosquito—*Culex quinquifasciatus*. These micro-filariæ develop, grow, and penetrating the tissues of the animal, pass to the base of the proboscis of the mosquito whence they are injected into a fresh host. The micro-filariæ are often harmless, but the adults—3 to 4 inches long and thread-like—block the lymphatic canals and cause enormous swellings of feet,

legs, arms and other parts of the human body—causing what is known as Elephantisis. A mosquito, which is quite harmless so far as Malaria is concerned, is therefore, instrumental in the transmission of Elephantisis.

Another terrible disease spread by insect-carriers is Typhus, which, on account of the carrier being human lice, appears in epidemic form during war. In fact it has been observed that war and Typhus go hand in hand. Serbia had a scourge of this disease in 1914, when, at one time there were over 9,000 deaths per day. The causative organism, probably a spirochæte, is taken up from patients and inoculated into healthy men. Monkeys, which were kept free from lice, remained healthy but contracted the disease after access had been given to body-lice from Typhus patients. It is remarkable that the infection is trnsmitted through the eggs to the next generation of lice, so that the progeny of infected lice are already infected without feeding on the blood of Typhus patients. Control of this disease is quite easy, since eradication of lousiness brings freedom from Typhus.

Finally, there are insects, the Porters, which give definite assistance in distributing a specific micro-parasite, but are not essential to its existence. The classic example of this type of insect is the flea, which transmits plague, a disease primarily affecting rats. An epidemic in rats always precedes an epidemic in man. The flea imbibes the specific plague bacillus from an infected rat and the bacillus multiplies in the mid-intestine of the insect, retaining the virulence for a week or more. The bacilli pass out in the excretá of the flea, which is freely expelled during the act of sucking of blood, and thus infect the wound inflicted by the insect on its new host—man. There is no definite adaptation of the bacillus to the flea or *vice versa*, and the bacillus may be disseminated in other ways. The common Indian plague-flea is *Xenopsylla cheopis*. Dengue and Kala-azar are two other Indian diseases transmitted by insect porters. The causative organism of Dengue is carried from man to man by the mosquitoes *Culex fatigans* and *Stegomyia*. Since these mosquitoes are usually present in large numbers the disease often appears in the form of widespread epidemics, though not always fatal. Kala-azar on the other hand is infectious and at the same time very fatal. Thousands of cases occur year after year in the province of Bengal alone. The disease is caused by *Leishmania donovani* (a protozoon) which is transmitted by the common Indian bed-bug (*Cimex rotundus*), the protozoon being found in all stages of development in the bed-bug.

We find, therefore, that over twenty-six of the common diseases, including the most widespread and fatal types, are transmitted by insects. The mortality figures due to these insects are appalling. In India, the mean annual death-roll, for the period 1920–29, due to the flea alone, is over 138,000 ; while the house-fly can claim a death-roll of 800,000 during the same period. The Anopheles mosquito is justly famed for its ravages in India, where more than 1,000,000 men succumb to malaria every year. The bed-bug, transmitting Kala-azar, has actually depopulated whole tracts in Assam and Bengal. It is common sense that a campaign against the causative infect species would surely eradicate most of the maladies that infest man in this most terrible manner. Much has been done in the West towards the eradication of disease-transmitting insects, but very little has been achieved in India, despite the sincere efforts of the Public Health Departments. Certain Indian towns have taken up the cue from the West and established noise-free zones ; how much better for the public it would be, if they established fly-free and mosquito-free zones instead. Cleanliness is the best and surest control for flies. As regards mosquitoes, they can be controlled to a great extent by adopting a few simple measures and strictly observing them. Larvæ should be destroyed by avoiding accumulation of water, using kerosene films on water where the source of water-supply cannot be stopped, and by rearing larvæ-eating fish in tanks and ponds. Recent researches have shown that the tadpoles of the Indian bull-frog are also effective destroyers of mosquito-larvæ.

Though the importance of insects in the dissemination of disease cannot be overestimated, it must be held clearly in view that any harm done to man by them springs up only secondarily, their primary business being the acquisition of food from us. The house-fly and blow-fly all over the world live in and around human dwellings, and may in certain circumstances be harmless to man. Such doubtful messmates as a blow-fly or blue-bottle may perhaps treat a living man as if he were dead. It may casually lay eggs in the nostrils of helpless or incompetent human beings, quite like a parasite. Here we see how an almost innocent commensalism may pave the way for parasitism. Again, an insect that can support life on sweet plant juices may take to sucking the blood of animals. This is the case with mosquitoes. The female Culicidæ (*Culex*) are a good example, for when they do not find blood they take to their original food,—plant juices. Bugs, again, are generally predacious, but bed-bugs have adapted themselves as specific parasites. Finally, there are parasites like lice which are associated with animals of a certain kind (mammals). Here the whole organisation is profoundly modified in the way of adaptation to the particular mode of life they lead. Wings are absent, legs are converted into grapnels for clinging to hair and the mouth parts form a suctorial tube which can be firmly enclosed in the host's skin. Even the eggs are firmly attached to the host's hair ; and the young louse, when it leaves the egg is a finished parasite like its parents.

Insects, therefore, should hardly be blamed for the maladies they cause in man, since the root-cause lies in the specific endoparasitic lethal micro-organisms which insects transmit quite unintentionally. We, however, do not desire to sit in judgment and give a verdict of 'guilty or not guilty'. Our first consideration is the welfare of mankind, and from this point of view insects are intolerable creatures. They are the most dangerous of man's enemies, veritable wolves in sheep's clothing. 'Our descendants of another century will stand in amazement at our blind toleration of such a menace to life and happiness.'

Wegener's Theory of Continental Drift.

UNDER the joint auspices of the Sections of Geology and Geography, Botany and Zoology, a Symposium on "Wegener's Theory of Continental Drift, with reference to India and Adjacent Countries" was held on 7th January, during the recent session of the Indian Science Congress at Hyderabad. Mr. W. D. West of the Geological Survey of India presided. In opening the proceedings, Mr. West gave a brief account of the theory and reviewed the various evidences for and against the idea of continental drift as conceived by Wegener. He said that this was a subject in which several groups of scientists were deeply interested, and the present symposium gave them an opportunity to meet and discuss this theory on a common platform. He then invited Dr. Sahni to open the discussion.

PROF. B. SAHNI (*Lucknow*) said that from a broad survey of the late Palæozoic floras, two striking facts emerge: (*a*) some countries with closely allied floras lie on the opposite sides of big oceans; and (*b*) others with very different floras lie dovetailed with each other. The question to decide was—could we explain these facts without the aid of the drift theory? Regarding the first point, he said that his attempt 10 years ago to compare the southern fossil floras from this point of view proved abortive, because our knowledge of the floras of corresponding points on the opposite coasts was too unequal to admit of a fair comparison; and the position to-day is much the same as it was ten years ago. Regarding the second point, he drew the attention of the house (with the help of maps) to the remarkable case of two very distinct floras which now lay very close to each other near Assam—the *Gigantopteris* flora of China and Sumatra, and the *Glossopteris* flora of India and Australia. These are two climatically distinct floras and their present contiguity obviously suggests a movement of these two floral provinces *towards* each other. Thus though it is true that we have not yet enough palæobotanical data to prove the drifting apart of the different remnants of Gondwanaland, yet we at least seem compelled to agree that movements of large magnitude elsewhere have brought into juxta-position continents once separated by a wide ocean. We cannot get away altogether from the idea of continental drift, but the details of Wegener's theory must stand on their merits.

DR. S. L. HORA (*Calcutta*) viewed the theory from the evidence afforded by the Indian freshwater fish fauna. With the help of a series of lantern slides, he pointed out that the freshwater fauna of India was derived by successive waves of migration, consequent upon extensive river captures, from east to west. He illustrated this with special reference to the Schilbeidæ—a group whose first appearance is indicated by some fossils in the Tertiary deposits of the highlands of Pedang in Sumatra—and pointed out that the relationships of these and other genera of fishes can only be explained on the assumption that their ancestral forms migrated from Indo-China, Siam, etc. His studies of the origin and geographical distribution of the Indian freshwater fishes negatived the theory of the permanence of oceans and continents, and indicated the existence of a land connection between India and Africa. Whether this connection was in the form of a land bridge between the two continents or the two continents were juxtaposed at some remote period but later drifted apart, it is very difficult to decide.

PROF. S. P. AGHARKAR (*Calcutta*) referred to the Palæo-African Element of the Indian flora, which he said must have reached India towards the end of the Jurassic and the Cretaceous period, when there was a direct land connection between Peninsular India and Africa through Madagascar. After mentioning a number of genera of this element and noting their present distribution, he was of opinion that these facts of observation could be better explained by Wegener's theory of continental drift than by any other hypothesis.

DR. A. K. DEY (*Calcutta*) in the course of his paper (read by Mr. D. N. Wadia in the absence of the author) compared the Jurassic and Cretaceous fossils of a number of areas in India, Africa and Madagascar, and doubted the effectiveness of a land bridge between India and Africa to account for the migration of flora and terrestrial animals. He pointed out that according to Grabau, India was joined to the Arabia-African continent *via* Iran only, throughout most of the Palæozoic time, and during the Mesozoic, they were joined in the Trias and lower Jurassic periods. Subsequently they were separated, and again joined during the Tertiary. During such intervals of land connections, inter-migrations of flora and terrestrial animals took place by this route only. Those who believe in the permanence of land and sea will probably agree with Grabau, and discard the necessity of interposing a purely hypothetical land connection across the Indian Ocean.

J. D. H. WISEMAN AND R. B. SEYMOUR-SEWELL (*Cambridge*) in their communication (read by Dr. S. L. Hora in the absence of the authors) gave a brief account, illustrated with lantern slides, of the floor of the Arabian Sea and the neighbouring areas of the Indian Ocean as mapped by them during the recent John Murray expedition. The region is traversed by several submarine mountain chains of which six were described in some detail. There is a remarkable similarity between the topography of the floor of the Arabian Sea and the region of the great rift-valley in Africa, the one being the mirror image of the other. It seems highly probable that the floor of the north-western part of the Indian Ocean assumed its present form as a result of compression in tertiary times, contemporaneous with the Alpine-Himalayan folding; and that subsequently, in Pliocene or post-Pliocene times, a tract of land occupying this area became faulted down to its present depth. There is little or no indication that any older continental mass or land isthmus such as the hypothetical continent of Gondwanaland or the isthmus of Lemuria, ever existed, except in the granitic mass of the Seychelles

and perhaps the corresponding granites of Sokotra and the Kuria Muria Islands.

Mr. P. Evans (*Assam*) pointed out that as seen from the detailed mapping of the Assam tertiaries, there had been a very great contraction in that part of the earth's surface since early Pliocene times. The distribution in time and space of the conditions which favoured the formation of oil, has been held to support a theory of continental spreading, but to favour Gutenberg's views rather than Wegener's.

Prof. L. Rama Rao (*Bangalore*) said that in discussing the validity of this theory, we must focus our attention on the history of the earth during the late Palæozoic and early Mesozoic periods, and that any conclusions based entirely on Tertiary and post-Tertiary phenomena will not be helpful. With reference to the evidence in India and adjacent countries, he said that our acceptance of Wegener's theory must largely depend on its bearing on the two important aspects of the late Palæozoic geology of Gondwanaland—(*a*) the distribution of *Glossopteris* flora and (*b*) the Permo-carboniferous glaciation. From both these points of view, the theory has been critically examined during recent years and there is a general agreement to reject it. The theory raises more problems than it proposes to solve. The remarkable case of two originally very distinct floras (the *Glossopteris* flora of India and Australia and the *Gigantopteris* flora of China and Sumatra) now seen in close juxtaposition and even dovetailed with each other, to which Dr. Sahni has drawn attention, no doubt suggests a movement of these two floral provinces *towards* each other and thus appears to support the general idea of a continental drift. But in view of the fact that the theory has been tried and found wanting in the solution of the more major problems of geological structure, palæo-climates, and former distribution of fossil floras, it seems doubtful if we have still to invoke the aid of this theory for explaining this particular occurrence. No other explanation may just now be possible, but in course of time, a more detailed knowledge of these two contrasted floras and a better understanding of the several factors controlling plant distribution may some day enable us to discover an alternative explanation which will be more easily acceptable.

The President (Mr. W. D. West) in bringing the Proceedings to a close said that they had spent a most useful afternoon in this discussion and thanked the various speakers for their valuable contributions. Whether we ultimately accepted or rejected this theory of Continental Drift, he said that there was no doubt that within the last 25 years, Wegener's theory had served a most useful purpose in stimulating and furthering investigation and research in several branches of science, leading to very valuable results. Likewise, he said, the discussion they had that evening was quite stimulating and enabled workers in different fields to understand one another better in the solution of a common problem.

L. Rama Rao.

The Teaching of Applied Chemistry in Indian Universities.*

Last year at the Indore session of the Indian Science Congress the Sectional Committee of Chemistry decided to elicit public opinion regarding the teaching of Technical Chemistry with regard to the following points:—

(1) Whether it is desirable to standardise the teaching of technical chemistry in various universities;

(2) Whether all duplication of teaching in different universities should be avoided;

(3) Whether it is desirable to approach Government departments and industrialists to give facilities to students for practical training in the factories and organisations under their control.

A circular letter on the above lines was sent to the different universities, provincial directors of industries, and prominent industrialists and industrial concerns. The replies received were quite encouraging and the matter was again thoroughly discussed in the Chemistry Section of this year's session of the Indian Science Congress at Hyderabad, Deccan.

Prof. R. B. Forster of Bombay University who opened the discussion said that Technology or applied science was based on pure science, and the latter on a good general education. He suggested that more attention be given to the study of practical English in the schools and that German could, with advantage, be introduced at an early stage. It was in these two languages that the bulk of the chemical literature was to be found. A good working knowledge of a foreign language was easily acquired by the young if taught by the direct method. For students who proposed to study science the matriculation examination in English should be modified so as to test the student's knowledge of the use of the English language rather than his knowledge of set books. Practical mathematics should be given a prominent place in the school curriculum.

It is doubtful whether Chemistry and Physics should be taught in schools, it depended largely whether the school was in a position to maintain adequate laboratories and qualified instructors, the imparting of book knowledge in science was of little value. In this connection he pointed out the great difference between Indian and European schools.

The stage at which applied science should be taught depended upon whether you wished to train, the artisan or the technologist. For the training of the technologist, he was in favour of an undergraduate course in pure science up to the B.Sc. standard and a post-graduate course in chemical technology, as this fitted in best with

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* Abstract of the discussion on "The Teaching of Chemical Technology," held on Tuesday, Jan. 5, during the Indian Science Congress Session, Hyderabad, 1937.

the system of education in India as it exists to-day. It also has the advantage of giving an opportunity for promising graduates to equip themselves to fill important posts in industry. He was not in favour of standardising the undergraduate courses on a cast iron basis as they would limit the activities of the institution but agreed that a certian minimum might be laid down. In the colleges more attention should be paid to the fundamentals of physics and chemistry and also to laboratory technique.

He suggested that the training in chemical technology should be on a broader basis rather than for specific industries.

With regard to technological training, he advocated allowing the largest measure of liberty in the framing of courses but suggested that before embarking on any course in chemical technology the institution should consider whether it has sufficient funds to carry its project through, whether there is a demand for the particular course and lastly if it is not duplicating work which is already being done at another place.

DR. SUBRAHMANYAN pointed out some of the difficulties under which teachers in applied chemistry were made to work and how difficult it was to get their work appreciated by the industrialist.

DR. NAIK was full of enthusiasm for the methods adopted in Germany and Russia in furthering the industries and the way in which education in technical subjects is carried on in those countries. He was very definite in his opinion that a stronger impetus should be given by Government to get any tangible and successful result.

DR. K. VENKATARAMAN said that the teaching of chemistry must constantly keep in mind its application to practical ends. While chemical technology has to be built on a sound basis of pure chemical knowledge, there is a certain danger in teaching technology as a post-graduate course. The possibility of recognising no dividing line between chemistry and chemical technology and of taking the two hand in hand must therefore be considered. An essential corollary to such a programme of teaching is to run the practical work as nearly parallel as possible to the lectures. A little workshop practice, rudimentary carpentry and advanced training in glass blowing are necessities to a technical chemist and might be regarded as desirable qualifications in a chemist of any sort.

Having in view the lacunæ in our school and undergraduate courses, the teaching of chemical technology can only be undertaken if extensive equipment is available. A department of technology, which sets out to impart advanced training in the subject, should include mechanical and electrical engineering laboratories and semi-scale plant for unit processes with the aid of which production on a reasonable scale may be demonstrated. Just as no amount of academic training can be a substitute for the factory apprenticeship which must precede a responsible position in industry, an unpaid apprenticeship in a factory cannot replace the semi-scale training that an adequately equipped University department can provide. An established factory works according to its own programme, where little chance is likely to be available for experimentation. Among the many demands met by the semi-scale plant may be mentioned: (1) the working of the essential plant and engineering details of a new process, (2) the preparation of a new product in sample batches for distribution to the trade, and (3) the improvement of operating conditions for a known process. Expenditure on buildings should be kept down to a minimum; inexpensive single storey structures with the ceiling high enough for the erection of temporary balconies for several levels of operation and divided into compartments with fire-proof walls are to be recommended.

Dr. Venkataraman wished to emphasise three points: (1) the desirability of having a continuous course in Chemical Technology of 3 or 4 years' duration rather than two consecutive and sharply divided courses in pure chemistry and chemical technology, (2) the need for semi-scale plant, and (3) the unavoidability, with regard to fundamentals, of a certain amount of duplication of teaching and equipment in the various universities.

Somewhat conflicting opinions were expressed by DRS. P. NEOGY, MOUDGILL and H. K. SEN about the exact stage at which the teaching in applied chemistry should start and what the curriculum should be. After some other members had taken part in the discussion, the President, PROF. J. N. RAY, summarised the present situation as follows :—

It is not possible to enforce an uniform standard as no unanimous decision can, at present, be arrived at. Therefore the individual universities should have complete freedom of action in this matter. Some duplication of teaching is bound to arise and is unavoidable. The universities, however, should specialise in those industries which are features of their area. Therefore there is need for the interchange of students. Several practical difficulties arise which have to be very carefully considered.

The following resolution was unanimously adopted :—

"That the Executive Committee of the Indian Science Congress be requested to approach the universities so that they may consider these suggestions and that the Executive Committee on the advice of Profs. R. B. Forster, K. G. Naik and H. K. Sen be requested to take all necessary steps through the Inter-University Board so that some tangible work may be accomplished."

N. C. CHATTERJEE.

Physics in Hungary—Past and Present*—II.

By Prof. R. Ortvay, *Budapest.*

IN this part, I wish to deal with investigations made by myself and by those who worked in some connection with me or with my institute.

I have mentioned on my investigations on the dielectric constant of some liquids under high pressure. Besides this I have dealt with problems in theoretical physics. Thus I have treated the problem of counting the number of self-vibrations of solids. I worked out a simple method for it, which has been accepted by some books, as *e.g.*, the well-known *Theoretical Physics* of Clemens Schäfer.

I have also stated an equation of state for solids, valid in the case of general deformation. My starting point was Debye's investigation, who gave an equation of state for uniform compression of solids, which resembles the one used for gases and liquids. I developed the characteristic temperature of Debye and so the free energy, in a series in terms of the deformation quantities. So I got a system of equations containing the deformation quantities and the temperature, thus being an equation of state in case of arbitrary deformation.

I have dealt with the theory of the well-known effect of Sagnac with help of the general theory of relativity.

I published several papers and a book in Hungarian about the Corpuscular Theory of Matter; besides, my lectures delivered at the University on the chief parts of Theoretical Physics were reproduced in five volumes.

As a professor at the University of Kolozsvár, Szeged and now of Budapest, I intended to excite interest in the modern problems of physics, especially in the theory of relativity, the corpuscular theory and quantum theory, and to stimulate my talented pupils towards similar investigations.

I was fortunate enough to find some amongst them, who have done valuable original and independent work.

One of these, Mr. Lánczos, now professor at Purdue University, Lafayette, in the United States of America, wrote his doctor's thesis on the theory of relativity. Later on Lánczos dealt especially with the problems of the theory of general relativity and gravity and also with problems of quantum-mechanics. At a time, when the matrix theory was already known, but wave-mechanics not yet, he hinted at such possibilities, of which due notice has been taken in science. In a fine paper he treats the Stark-effect in the case of strong electric fields and explains the phenomena arising from the indistinctness of the spectral lines.

Mr. I. Kudar made some investigations concerning the theory of relativity and the quantum-theory and the mechanics of solids. Of these I may mention the quantum-mechanical treatment of the redshift and the statement of a relativistic invariant form of the wave equation of Schrödinger, which he found simultaneously with but independently of others (Gorden, Klein, Schrödinger). This equation is now only of historical interest, but it was a great success at the time.

The scientific work of Mr. Tibor Neugebauer is more important and more extensive. His researches extend to the theory of the optical Kerr-effect, and the dynamics of crystal lattices; especially he clarified the role of polarisation in different phenomena, such as the increase and diminution of refraction. He dealt with the conductivity of the electricity of crystals, the Van der Waals' force, and finally he calculated the constants of some molecules.

The aim of the investigation concerning the Kerr-effect was to explain the electrical Kerr-effect or the electrical double-refraction on the basis of quantum-mechanics and to compare it with existing classical quantum-theoretical theories.

Mr. Neugebauer takes into consideration not only the alteration of the single levels of energy of the molecule under the influence of the electric fields, but also the change of the distribution of the number of molecules belonging to certain energy levels. His theory contains as particular cases the classical theories, both the theory of Voigt based on the Stark-effect and the theory of Langevin-Born-Kronig based on the orientation of the dipoles. He is able to explain the general character of the phenomenon and the order of magnitude of the effect, but unable to state numerical values.

One important result of his investigations is that in agreement with experience molecules of nearly spherical symmetry, as carbon tetrachloride (CCl_4) can produce a Kerr-effect which in this case arises according to the theory of Voigt. He also investigated the Kerr-effect of molecules with axial symmetry and got satisfactory results.

The further scientific research of Mr. Neugebauer tends principally to explain thoroughly and numerically the phenomena accompanying molecules and crystal lattices as far as possible without any empirical parameter. This kind of research is not so remarkable as the qualitative explanation of a whole district of phenomena by means of a general conception, nevertheless, it is indispensable because the limits of a theory can only be found if worked out thoroughly and compared with experience not only in general but also in particular. This is why such minute calculations are often indispensable.

His investigations about crystal lattices and molecules lead to remarkable results especially as he carries them out with the help of careful calculations on the polarisation. So, in a paper published together with Mr. Gombás, they were able to determine the lattice constant of the potassium chloride (KCl) with an error of 4·3 per cent. only, and the lattice-energy with an error of 4·4 per cent. They took into account the circumstances, that in the case of equilibrium in the place of a point-like ion the resultant of the forces arising from the other ions disappears. It does not disappear, however, in all points of

* From a lecture delivered at the Indian Institute of Science, Bangalore, on 5th January 1937.

the electron-cloud belonging to the ion; and that renders polarisation possible. To perform their calculation they have used the characteristic functions (Eigenfunktions) of Hartree and the statistical atom model of Thomas and Fermi in the form given by Lenz and Jensen.

In another paper Neugebauer calculates the polarisation energy of different kinds of lattices of binary crystals. His calculation shows, that in the case of highly-symmetrical lattices, as of the rock-salt or cæsium chloride type, in the development of the polarisation-energy into a series in terms of spherical harmonics, the first non-vanishing term contains the fourth spherical harmonics, in the case of a lattice of zinc blende and wurzite-type the third, in the case of nickel-arsenide-type the second and in the cases of molecular lattices or film-lattices the first spherical harmonics. The electronic conductivity of the different kinds of lattices also varies in connection with the latter. It grows with polarisation, reaches a maximum at the type of nickel-arsenide and disappears again in the molecule-lattices. With the help of polarisation he could explain the isosterism of Langmuir, according to which crystals, in which the two ions have the same number of electrons and the same configuration of the inner electrons, also have equal lattice-constants. He explains why isosterism appears with the type of zinc blende and wurzite and why it disappears with the type of sodium chloride.

Another paper treats the diminution of refraction in atom-crystals, which phenomenon is known only since the extended researches of Fajans and Joos; he explains it also with the help of polarisation.

I have to mention his thorough investigations on the molecule of methane, the first polyatomic molecule precisely studied. He succeded in determining the distance of the hydrogen and the carbon atoms with an error of 2·1 per cent. and the energy with an error of 12·5 per cent. He investigated the stability of the model and ascertained the frequencies of fundamental vibrations in good agreement with experience.

He gave a formula for the Van der Waals' forces, which is a better approximation than the formula used by London and Kirkwood.

P. Gombás's researches are of a similar kind to those of Neugebauer. I have already mentioned his paper published with Neugebauer about the potassium chloride molecule. They used here the statistical atomic model of Lenz and Jensen. Gombás applies the same atomic model to calculate the diamagnetic susceptibility of atoms and to evaluate the constants of the lithium-bromide crystal. His results are in good agreement with experience.

He treated very thoroughly the theory of metallic linkage especially those of the alkali metals which have only one valency-electron in each atom.

He started from a supposition of Herzfeld and Bomke, according to which the valency-electrons would distribute themselves continuously over the whole lattice of positive ions and the breaking-down of the lattice would be only prevented by the zero-point energy of the electron cloud; but this theory did not lead to satisfactory numerical values of the lattice-constants. Gombás perfected this theory as follows: he took into account beside the Coulomb energy of the ion-lattice and the zero-point energy of the electron-cloud also the exchange-energy of the latter and the energies arising from the penetration of the electron-cloud into the inner levels of the atom and of the mutual penetration of the electron-clouds of neighbouring atoms. Another energy has also to be taken into account according to Wigner and Seitz, arising from the mutual influence of electrons with anti-parallel spins. It is a fine qualitative result of his, that a metallic hydrogen crystal cannot exist; this is a well-known fact. He proved an inverse proportion between the energy of alkali-crystals and their lattice-constant.

He calculated the lattice-constants, lattice-energies and sublimation-heats of potassium, rubidium and cæsium in agreement with experience with an error of 12%-16%.

He calculated also another type of lattice, the lattice of krypton. This is kept together by Van der Waals' forces. He could calculate this with the help of Neugebauer's formula.

At last he worked out in connection with the theory of Fermi and Thomas a statistical perturbation theory with consideration of exchange and without it. That method permits the calculation of the electric moment induced in an atom by an external electric field.

L. Tisza treats the vibrational spectra of molecules with the help of the theory of groups.

This is the scientific work performed in my Institute.

III.

The researches of Hungarian scientists who live abroad and are partly citizens of some foreign countries form a large and very important part of Hungarian physics.

I have already mentioned in the first part C. Lánczos, now Professor at Purdue University in Lafayette, who dealt with general relativity, quantum-theory and Stark-effect.

One of our most successful scientists E. Wigner, Professor in the University of Princeton, N.J., U.S.A., made some fundamental statements in theoretical physics including some boundary problems in chemistry. His paper concerning the number of terms which do not combine with each other was a starting point for many important researches and brought about the exploitation of the theory of groups. This method permits the logical wave-mechanical treatment of spectra, which was worked out by V. Neumann and Wigner in a series of papers published together. The group-theory gives mathematical aids for the theory of chemical linkage of Heitler and London and allows one to determine the character of the terms of a di-atomic molecule, if the terms of the atoms are known. (Wigner and Witmer.) Now group-theory belongs to the standard methods of theoretical physics necessary chiefly in subtle investigations. Wigner's book on group-theory and spectral lines is one of the best of this kind.

Further he dealt with nuclear problems, such as the mass-defect of helium, the interaction between neutron and proton, etc.

He investigated the natural breadth of spectral lines by the application of Dirac's light theory.

Wigner and Jordan published a paper which is very important from the point of view of general quantum-mechanics because of its new method of quantisation. Here they do not use the polydimensional configuaration-space of Schrödinger, but the ordinary three-dimensional space, introducing waves with non-commutative amplitudes.

His investigations on proper chemical problems are of great interest. In one of his papers, published with Polányi, he gives an explanation of the velocity of mono-molecular chemical reactions. In another paper he treats the para-orthohydrogen reaction under the influence of paramagnetic molecules as catalysts. He gives a satisfactory explanation of the magnitude of the velocity of this reaction and its dependence upon the magnetic moment of the catalyst.

Another prominent scientist in theoretical physics and mathematics is J. von Neumann, Professor at the Institute for Advanced Study, Princeton, N.J.

His investigations in mathematics extend to the theory of sets, geometry, group-theory, and the theory of games. I want to call special attention to his profound investigations concerning the theory of linear operators, which is not only an indispensable aid in quantum-mechanics, but also a very useful help in general dynamics.

He has carried out fundamental investigations in the field of quantum-mechanics. I have already mentioned that he and Wigner worked out the application of group-theory to the theory of spectra.

Further he recognised the idea of the "Reiner Fall" at the same time, but independently of Weyl. This idea is fundamental in quantum-mechanical statistics, but is not treated satisfactorily in most of the books on physics.

He published several papers dealing with general problems in quantum-mechanics, the principal significance of statistics, the second law of thermodynamics, the ergodic hypothesis in quantum-mechanics, etc.

His well-known book *Mathematische Grundlagen der Quantam-mechanik* gives a correct treatment of the transformation theory without the help of the very singular δ of Dirac, which is important from the standpoint of exact mathematics.

One of his most important results was that he determined the conditions of validity of a classical assumption in general dynamics, the so-called "ergodic-hypothesis" with the help of the method of operators.

E. Teller, now at the University of Washington, worked with remarkable success on the borderline of theoretical physics and chemistry. His paper about the quantum-mechanical treatment of the ionized hydrogen molecule is well known. In several papers he deals with the vibrational spectra of polyatomic molecules and the rotational part of the Raman spectrum. In an interesting paper he treats the question, when and how the elastic frequencies of a long chain-like molecule are modified, if we substitute a radical into it. He gives in the *Hand und Jahrbuch der Chemischen Physik* in two long and clear articles a survey of the elastic vibration of molecules and crystal-lattices.

Now he deals with nuclear problems.

A. Wintner, now at the University of Baltimore, worked on the theory of matrices and published a book on it in German. Further he dealt with celestial mechanics and problems of three bodies.

One of our most prominent scientists is Th. v. Kármán, formerly Professor at the Polytechnicum of Aix-la-Chapelle, now at the California Institute of Technology in Pasadená. His papers written together with Born on the theory of specific heats are well known. They were the first to treat the vibrations of a real crystal, as vibrations of a lattice; they did not approach it from the point of view of a continuum theory as did Debye.

A very important result of his was the determination of the hydro-dynamical resistance of a cylinder to a current of liquid or air and the thorough treatment of the hydrodynamical problems associated with it. The discovery of the series of whirls has very important consequences in aero-dynamics.

Very serious researches are going on in his famous institute especially in aero-dynamical problems, in which he is a well-known authority.

E. Orován, former Assistant at the Technological School in Charlottenburg, obtained some good results in the mechanics of solids. He showed that it is possible to understand the phenomena of plasticity and the great discrepancy between experimental and theoretical tensile strength on the basis of Griffith's theory of surface cracks. He brought the phenomena of plasticity at high and low temperatures into a close connection and showed that they are both governed by the same statistical formula of Becker.

Another very distinguished scientist in physical chemistry is G. V. Hevesy. He was in Budapest, then in Freiburg (Germany), at the University; now he is in Kopenhagen. His experimental investigations in physics and in physical chemistry are important. He has some valuable results which characterise his whole work:

1. He and Brönsted were the first to separate isotopes. They did it in the case of mercury.
2. He discovered Hafnium and separated it.

When the 72nd element of the periodic system of elements was not yet known, most of the scientists thought that it was amongst the rare earths. Hevesy found, according to Bohr's atomic theory, that this element was not homologous with the rare earths, but with zirconium an element which precedes them with a great period of 32 between. He sought it in minerals containing zirconium, and actually found it there. It was identified by Coster with the help of X-rays; the very subtle chemical separation was made by Hevesy himself.

3. He discovered the radio-activity of Samarium. Besides the great radio-activity families there are two natural radioactive elements: potassium and rubidium, both emitting β-rays. But samarium emits α-rays of very short range.

Besides this he has other investigations on some physical and chemical subjects performed with the aid of radio-active indicators, *e.g.*, on heavy water, ionic conductivity, etc.

An important and well-known scientist is M. Polányi, formerly in Berlin at the Kaiser-Wilhelm Institute, now at the Victoria University in Manchester. His important scientific

work lies outside the scope of my work, its character being chemistry proper. Therefore, without intending to diminish its importance I shall characterise it only with a few words.

Well-known are his investigations on the elementary chemical processes, which he investigated under favourable conditions, for example in the state of rarefied gases. He made some important researches on the structure of fibrinous matter with X-rays and elaborated suitable methods for the study of monocrystalline metals. We have mentioned above his investigations on the quantum-theoretical treatment of chemical processes published together with Wigner.

Well-known scientists are the two Farkas brothers: A. Farkas and L. Farkas; the first lives in England, the second in Jerusalem. His researches on *ortho-* and *para-*hydrogen, on heavy water, etc. are well known, also the English monograph of A. Farkas on hydrogen.

L. Szilárd, former "Privatdozent" at the University of Berlin, excited the interest of scientists with some important remarks. He thoroughly discussed the second law of thermodynamics from the standpoint of the statistical theory, and showed that the fluctuation phenomena are not in contradiction with the phenomenological theory. Szilárd was the first to observe the disintegration of the Be^9 nucleus by ν radiation. Apart from He, this was the first example of photo-disintegration in nuclei. He was the forerunner of Fermi, observing that different nuclei respond to different groups of slow neutrons, and he already estimated the energy of the neutron groups by the same method which is now generally adopted. In a way, he thus laid the experimental foundation to Bohr's famous ideas on nuclei, expanded last winter.

Before finishing, I wish to enumerate a few scientists, who lived in Hungary, but whose work falls outside the proper range of physics, but touches parts of this science, *e.g.*:

Baron H. Harkányi, Astronomer, first determined the effective temperature of stars with the aid of the law of Planck.

R. Kövesligethy, Astronomer and geophysicist, reached some fine results in seismology.

E. Cholnoky, Professor of Geography, first called attention to monsoon-like phenomena observed in Europe.

I have mentioned at the beginning, that one of the most important technical devices, the dynamo-principle, was discovered by A. Jedlik long before W. Siemens, but he could not perceive its practical importance. This was not the case with electrical transmission of force. Both, the idea and the full execution were due to Hungarians resulting in the transformer of Déri-Bláthy-Zippernowsky.

The Jendrassik-Ganz heavy oil motor worked out by G. Jendrassik is one of the best of its kind and is well known all over the world.

I hope this short summary will produce the impression that Hungary, notwithstanding her bad conditions, works hard and succesfully in some parts of science.

RESEARCH ITEMS.

Contribution to the Theory of Schlicht Functions.—Pesch ("Zur Theorie der Schlichten Funktion" *Crelle's Jour.*, (B), **176**, 61–94) has made interesting contributions towards the solution of the coefficient-problem of schlicht functions. He has obtained some general theorems about the variability of the coefficients $a_2, a_3, \ldots a_n$ of a function $f(z) = z + a_2z^2 + \ldots a_nz^n + \ldots$ schlicht in the unit circle; *i.e.*, he has obtained some results concerning the region $B_s^{(n)}$ in a $(2n-2)$ — dimensional space where $B_s^{(n)}$ comprises all points $(a_2, a_3, \ldots a_n)$ for all schlicht functions. Even with the intricate analysis that the author uses only very little knowledge can be gathered about $B_s^{(n)}$. He has also considered the regions $E_s^{(n)}$ formed by the a's when they are all real and the corresponding regions in the case of functions which transform the unit circle into star regions. (A region is said to form a star region about the origin when every line through the origin intersects the boundary of the region only once.)

At the outset he proves a theorem about the approximation of schlicht functions by means of the iteration of functions which transform the unit circle into the same with a radial slit issuing from a boundary point. (He makes the proof dependent on a difficult theorem of Lowner.) He shows that by means of this theorem some fundamental results such as $|a_2| \leqslant 2$, $|a_3 - a_2^2| \leqslant 1$ follow immediately; at the same time he shows that all results cannot follow (*i.e.*, such results are not iteration-invariant), *viz.*, $|a_3| \leqslant 3$. After proving some general results concerning the coefficient-regions he also proves some results concerning the coefficients of functions corresponding to star regions. One such result is the following:

If $S(z) = z + s_2z^2 + \ldots$ transforms the unit circle into a star region and if

$$\frac{S}{S_1} = z + 2\sum_2^\infty \sigma_v z^v$$

then

$$\begin{vmatrix} 1 & \sigma_2 & \cdots\cdots & \sigma_n \\ \bar{\sigma}_2 & 1 & \cdots\cdots & \sigma_{n-1} \\ \cdots & \cdots & \cdots & \cdots \\ \bar{\sigma}_n & \cdots & \cdots & 1 \end{vmatrix} \geqslant 0.$$

He has also obtained a partial differential equation satisfied by all functions transforming the unit circle into regions with multiple slits (the result in the case of a single slit is due to Lowner). He has studied in detail the region $B_s^{(3)}$. An interesting result he obtains in this connection is the following:—For every Schlicht $f(z) = z + b_2 z^2 + b_3 z^3 + \ldots$ we have

$$1 \geqslant R\,\beta_3 \geqslant 2\,\phi\,(R\beta_2) - 1 \text{ where } \beta_2 = -\frac{b_2}{2},$$

$$\beta_3 = b_2{}^2 - b_3 \text{ and } \phi(x) = \frac{x^2}{\lambda^2(x)}\,[2\lambda\,(x) - 1],$$

$$x = \lambda\, e^{1-\lambda}.$$

K. V. I.

The Structure of Boron Hydrides.—In surveying the present position of our knowledge regarding the structure of Boron hydrocarbons E. Wiberg (*Ber.*, 1936, 69, 2816) points out that the electron distribution in these hydrocarbons is difficult to understand as there are, *e.g.*, in the simplest hydrocarbon B_2H_6, 12 valency electrons although apparently there must be here as many bonds as in ethane C_2H_6 with its 14 electrons. The formula proposed by the author in 1928 with an ethylenic double bond between the two Boron atoms, 4 co-valently bound and 2 electro-valently bound hydrogen atoms as in $\overset{-}{B}\overset{+}{H}H_2 = \overset{-}{B}\overset{+}{H}H_2$ fits in best with several physical and chemical properties. The stable position of the two protons seems to be inside the orbits of the double-bond electrons and as only protons can occupy such a position when it is attempted to substitute them by other atoms or radicals, the molecule splits as into BCl_3, $(CH_3)_3$, etc. The constitution of the corresponding $\overset{-}{B}_4\overset{+}{H}_{10}$ is given by $\overset{-}{B}\overset{+}{H}H_2 = \overset{-}{B}\overset{+}{H}H - \overset{-}{B}\overset{+}{H}H = \overset{-}{B}\overset{+}{H}H_2$. The acid character of these compounds, as exhibited by the formation of ammonium salts, can also be represented by the simpler formula $(B_2H_4H_2)$ and $(B_4H_6)H_4$. Their unsaturation is shown by the formation of addition compounds with alkali metals. Other evidences in support of the unsaturated poly-basic acid character are provided by dipole moment, ultra-violet absorption, and magnetic measurements.

M. A. G.

The Potash-Soda Felspars.—The results of investigations of the optical properties and chemical composition of 26 potash-soda felspars, have been reported in a paper by Dr. Edmondson Spencer, read at a recent meeting of the Mineralogical Society, London. In the orthoclase-microperthites there is almost linear relation between specific gravity and optical properties and Ab-content. Specimens were heated (*a*) to near melting for a short period, and (*b*) for several days at 1075° C. Refractive indices decrease on heating between 400° and 850° C., and *d* also decreases. Heating to 1120° produces little further change. Very slow cooling from 800° to 350° restores the schiller and the lost refractive index and sp. gr. It appears that perthite can be dissolved and re-precipitated more readily than has been thought possible.

A structural explanation of the formation of perthite lamellæ is offered.

A new equilibrium diagram for temperatures down to 800° C. is given. It is argued therefrom that residual granite magma at about 800° in presence of much water and free silica splits gradually into a soda-rich and a potash-rich fraction. The occurrence of potash-felspar crystals in xenoliths, the origin of the microcline of pegmatites, of 'vein' perthite, and of quartz-microcline intergrowths are other points discussed.

The Nitrogen Supply of Rice Soils.—In the *Indian Journal of Agricultural Science* (6, Part VI) P. K. De draws attention to the fact that in Bengal and in Burma rice is being grown for centuries year after year on the same land without the addition of any fertiliser and attempts to answer the question as to where the crop gets its supply of nitrogen from. Two possibilities are suggested, *viz.*, that rice may be capable of assimilating elementary nitrogen like the legumes or that nitrogen fixation may take place in the water-logged soil sufficient to make up for the quantity removed by the crop and lost otherwise. The second possibility has been studied by him amd the conclusion is reached that such fixation does take place in water-logged condition and under sunlight. Increases of nitrogen from less than 1 per cent. up to as much as 33 per cent. over the initial quantities were observed. Soils with a high pH value were found to be more active than others and even these latter became active with the addition of lime. The agency for such fixation is tentatively put down as algal growth, either by itself or with the help of bacteria.

The Arrowing of Sugarcane.—The subject of the arrowing or flowering sugarcane in its important agricultural aspects has been comprehensively studied and the results of several years' work brought together by K. Krishnamurthi Rao and K. V. Gopala Iyer (*Agric. and Livestock in India*, 6, Part V). The conclusions may be summarised as follows:—Arrowing is no indication of maturity; on the other hand, the juice of arrowed canes continues to improve for a long period after the arrowing; increase in sucrose content and purity is noticed till two to three months after full arrowing and to an extent of three to four per cent. in sucrose and five to eight per cent, in purity. Arrowing stops further growth of the cane almost entirely, and greatly takes away therefore from the tonnage that may be expected from canes which continue to grow without arrowing, two or three months after arrowing the weight of the arrowed canes to the weight of non-arrowed cane is as 1 : 1½ or 2. By this time the sucrose content of the non-arrowed cane becomes equal to that of arrowed canes. Calculated in total sugar values, the maximum available sugar in one hundred lbs. of arrowed and non-arrowed canes of P. O. J. 2878 variety was 22·88 lbs. and 34·10 lbs. respectively; other varieties also showed similar differences. If these figures are calculated on the acre basis, the magnitude of the loss due to arrowing will be found to be astonishingly large.

Seedling Canes in Bihar.—The possibility of breeding sugarcane varieties in Upper India which has for long been doubted has now been demonstrated by the successful work in this direction carried out in Bihar by K. L. Khanna, of which an account appears in *Agriculture and Livestock in India* (7, Part I). Although the fertility of the flowers and seed-setting have been erratic under field conditions uniformly good results have been obtained under conditions of controlled temperature and humidity; and a large number of seedlings from different selfs and crosses have been raised to maturity during the past three seasons. The following observations made in the course of the work will be found interesting:—Sugarcane seed, thoroughly dried and kept without any preservative, remained viable for over seven months and they lost viability

only during the rains. Instances of sugarcane seed keeping viable for over two months after being sown in the open were also observed. Seeds from different varieties and combinations differed in their vitality and viability, the stronger pollinating parents being found to produce seeds which kept viable over longer periods. For germination of sugarcane seeds in Petrie dishes acidified distilled water was found to afford protection against fungus attacks and also to produce better germination. The flowering of canes has been both induced and hastened by growing them in special soils and by injecting into the canes at different stages of growth certain chemicals such as mercuric chloride and ferrous sulphate in doses of varying concentrations. Several useful cultural hints as well a data regarding the flowering, pollination and fertilisation in cane are described in detail.

Deep-focus Earthquakes and their Geological Significance.—Such of the geologists who suspected the existence of deep-focus earthquakes will read with interest the contribution of Leith and Sharp (*Journal of Geology*, **44**, No. 8) on this subject, and would probably like to revise some of the old and untenable dictums of seismology. The authors have given numerous examples of deep-focus earthquakes, referred to by Wadati near Japan, where some of the earthquakes are believed to have taken their origin from 700 km. and downwards. From these and other examples, Leith and Sharp estimate that nearly 10 per cent. of the earthquakes originate at great depths. They have further examined the conditions of temperature, viscosity, rigidity and strength in relation to the behaviour of the materials at such great depths. Incidentally, discussing the geological significance of such earthquakes, they have questioned the very existence of the asthenosphere or the zone of flow. Their conclusions are of great importance, and are likely to modify the present views on crustal mechanics in general and isostasy in particular. The paper is well illustrated with numerous figures, maps and charts.

Sexual Periodicity.—In an admirable Croonian lecture, F. H. A. Marshall (*Phil. Trans. Roy. Soc. Lond.*, (B), 1936, 539) describes the sexual periodicity and the causes which determine it. An alternation of active and quiescent periods induces an internal rhythm of reproduction. The secretion of hormones which act upon the accessory organs and sexual characters is correlated with this rhythm. In the absence of pregnancy, the successive repetition of the follicular (œstrous) and luteal phases is controlled by the mutual interaction of the pituitary and the ovary. Generally it may be said that in all higher animals sexual periodicity, while conditioned by environment, is regulated in its successive phases by the combined integrative action of the nervous and endocrine systems. "The primary periodicity is a function of the gonad the anterior pituitary acting as a regulator, and the internal rhythm is adjusted to the environment by the latter acting on the pituitary, partly or entirely, through the intermediation of the nervous system. The further fact, however, must not be overlooked, namely, that in the absence of the anterior pituitary the functions of the gonad fail, so that the pituitary in common with the other endocrine organs, conditions the metabolic processes which are essential for reproduction".

SCIENCE NOTES.

Recent Geological Changes in Northern India.—In the course of an extension lecture recently delivered under the auspices of the Faculty of Sciences, Lucknow University, Mr. D. N. Wadia dealt with the recent geological changes in Northern India and their effect upon the drainage of the Indo-Gangetic basin. At the very outset, he pointed out that the earth has no claim to be called a *terra-firma* as the earth's crust possesses no real stability. The surface features of this crust, the distribution of sea and land, continents, mountains, rivers, lakes are subject to constant and ceaseless change and every geological age comes to possess its own geographical features. The changes that have taken place in India since the last geological age the Pleistocene, have been of great magnitude and importance. He then gave a brief account of the changes in each of the three great natural physical divisions of India, the Peninsula of Deccan, the Indo-Gangetic plains and the Himalayas. In the latter part of his address, he referred to the recent drainage changes in Northern India. During a very late geological epoch a great river flowed from Assam to the Punjab and Kohat, thence turning southward flowed towards the Arabian Sea. The course of this ancient river—the Indo-Brahm of Sir Edwin Pascoe—is revealed to us to-day by the alluvial deposits it laid down along its valley. A differential elevation taking place near the Potwar Region of east Punjab at the end of the middle Pleistocene, severed this Indo-Brahm River into two portions—the upper half taking an easterly course into the Bay of Bengal forming the present Ganges and the lower half which continued to follow the north-westerly and then southerly course towards the Arabian Sea, forming the present Indus. The River Jumna was at first an affluent of the Indus with a westerly course; and later, a tributary of the Ganges captured this stream and drained it eastward. In conclusion, he detailed the various evidences of recent geological changes in the Himalayas indicating that these mountains have been elevated several thousand feet since the Pleistocene.

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Royal Asiatic Society of Bengal.—The Annual Meeting of the Society was held on the 15th February.

The Rt. Hon'ble Sir John Anderson, P.C., G.C.B., G.C.I.E., M.A., B.SC., LL.D., presided.

The following were elected Fellows:—Dr. K. N. Bahl, Mr. K. N. Dikshit, Dr. N. N. Law, and Dr. J. N. Mukherjee.

The following were elected officers and members of Council for 1937 :—*President* : H. E. The Rt. Hon'ble Sir John Anderson ; *Vice-Presidents* : Rai Sir Upendra Nath Brahmachari, Bahadur, A. M. Heron, Percy Brown, Lt.-Col. N. Barwell; *General Secretary* : John Van Manen ; *Treasurer*: S. L. Hora ; *Phylological Secretary* : S. K. Chatterji ; *Joint Phylological Secretary* : Shamsu'l Ulamā Mawlavē M. Hidāyat Hosain, Khan Bahadur ; *Natural History Secretaries* : *Biology* : Baini Prashad, *Physical Sci nce* : J. N. Mukherjee ; *Anthropological Secretary* : Rao Bahadur Ramaprasad Chanda ; *Medical Secretary* : Brevet-Col. R. N. Choptra ; *Library Secretary* : M. Mahfuz Haq ; *Other Members of the Council* : C. C. Calder, N. G. Majumdar, K. C. Mahendra, The Hon'ble Mr. Justice John Lort-Williams, B. S. Guha and W. D. West.

The Government of India have agreed to the permanent loan to the Society of a large collection of 12,000 Sanskrit manuscripts, hitherto preserved by the Archæological Section, Indian Museum, Calcutta.

The following exhibits were displayed at the annual meeting of the Society :—Illustrated Old Indian Manuscripts and manuscript covers, (2) Wooden effigies of the red kaffirs of the Hindukush mountains, (3) Painted pottery from Nal, Baluchistan (*c.* 3000 B.C.), (4) The ferro-alloys, (5) Series of specimens and diagrams illustrating the evolution of cephalopods, (6) Specimens and photographs of the oldest fossils from India, (7) Micro-structures of fossils, (8) Cast of the skulls of fossil man, (9) The Society's publications of 1936 and (10) Some recent publications by members of the Society.

The Rt. Hon'ble Sir John Anderson delivered the Presidential Address on " A Study of the Conception of Power in the Social Organism " comprising " a few reflections which attempt to bring the conclusions of the biologist into relation with the conclusions—still inchoate—of the student of the social and political organisation of mankind ". " Power is a concept common to biological, philosophical and political studies." The address concerned itself with the attitude of man towards power, rather than power itself : "what have men conceived its nature to be ? Is there traceable in those various conceptions any development camparable to the development in the physicl organism that is known to the biologist as evolution ? If there is any such development is it progressive—does it point to an ultimate conclusion—can we compare the attitude towards power or authority of different men at different times and say that this or that attitude is an index of a higher development in the social organism than some other attitude ? If so, can we trace anything like an ordered evolution in the social and political development of mankind and can we forecast its direction ?"

* * *

Irrigation Research in the Punjab.—The *Report* of the Punjab Irrigation Institute for the year ending April 1936, which has been recently published gives a brief account of the research work that has been carried out in the various sections of the Institute bearing on the many important phases of irrigation engineering, and of farming in the canal-irrigated tracts including the reclamation of alkaline soils. Among much that is of local interest and application to the canal-irrigated tracts of the Punjab, a good many problems investigated are of fundamental importance and may be found applicable over large areas outside the tract also. Of much general interest is the study of the nature and modes of formation of kankar nodules, which under Punjab conditions is to be looked upon as a natural process of soil improvement in which the replaceable sodium in the upper or root range zone of alkaline soils tends to be replaced by calcium. The seepage losses through channel beds has been successfully prevented by making the beds impermeable by the application of sodium carbonate, a result usually sought to be attained by lining the beds with suitable material. If developed on a really large field scale it is obvious that this recommendation should be of far-reaching importance. Some encouraging results of small-scale experiments on the reclamation of alkaline soils by electrodialysis are described, the economics of which awaits to be studied. Considerable work in the chemical section has also related to the standardisation of methods for the estimation of various soil constituents such as exchangeable lime, sodium and potassium and available phosphates.

Research work with a view to improving the efficiency of weirs, dams and other irrigation works has been continued chiefly through the study of working models. A very notable result attained is one relating to the Marala Weir, a large pre-War structure one mile in length, defects in which were located and substantial reconstruction carried out avoiding thereby a probable collapse of a serious and costly nature.

The work on the reclamation of alkaline land has been continued on the same lines and it is interesting to notice that the improvement has been so marked that the yields of rice from reclaimed areas have been consistent and very much higher than these obtained on even good land ordinarily under cultivation. A somewhat interesting attempt to correlate the nature of tree growth with the composition and other characteristics of the soil and to see how far this can be taken as indicating the value of these soils has also been made and some tentative conclusions drawn.

A good deal of advisory work in regard to irrigation works and water-supply projects for both governments and private parties has also formed part of the activities of the Institute. The year's work in fact bears ample testimony to its usefulness as a scientific institution in matters of great practical importance in irrigation and agriculture.

* * *

Archaeological Survey of India.—The consolidated annual report of the Survey, chronicling the activities of four years ending March 1934, has recently been issued.

Among the important finds made at the excavations at Mohenjodaro in Sind which were continued up to the end of 1931, are, a linear measure with regular markings which shows that the decimal system was known and used in India in about 2700 B.C. ; a clay seal depicting a complicated legendary scene of tree worship and a drawing of great interest portraying a river boat. Excavations at Harappa, in the Punjab, have resulted in the discovery of a number of skeletal remains and pottery, jars with skulls and human bones. Another discovery

is a portion of the city which can justly be described as workmen's quarters.

The excavation of the lofty temple and magnificent monastery at Paharpur which started in 1923, was recently completed. The monastery measures 922′ × 919′ and contains 200 cubicles for monks, arranged round a vast courtyard with an imposing 4-terraced temple in the middle and various other structures at other points ranging in date from the 5th to the 11th century A.D. The structural complex at Paharpur is one of the most gigantic extablishments ever found in this country.

The report deals with the discovery of Buddhistic and Brahmanistic wall paintings in Burma by Maung Mya. Details are also given of voluminous epigraphical works. Besides excavations and discoveries, extensive conservation work was also carried out by the Department. The number of monuments repaired run into hundreds of which two outstanding instances are the work carried out at the ancient Buddhist monastic school of Nalanda, and that at the famous Buddhist site Rajgir.

* * *

Indian Central Cotton Committee.—The 34th meeting of the Indian Central Cotton Comittee was held on the 2nd and 3rd March, at its headquarters in Bombay and was presided over by Sir Bryce Burt, the President of the Committee.

According to a press communique issued by the Secretary of the Central Cotton Committee, the subjects examined by the Agricultural Research Sub-Committee are: the proposed scheme for the extension of 'Jarila' cotton in Khandesh in place of Banilla; the deputation, recommended by the Sind Provincial Cotton Committee of an agricultural officer abroad to study the cultivation, ginning and marketing of American and other long-staple cottons; the review of the Final Report on the Hyderabad Cotton Scheme and the Progress Report on the Punjab Physiological (Cotton Failure Research) Scheme; the consideration of the proposed extension of the Punjab Pink and Spotted Boll-worm scheme and the Sind Physiological scheme and the new research schemes for cotton jassid investigation in the Punjab and the improvement of Mungari cotton in the Madras Presidency.

The proposal for the establishment of closer contact between mills and the Technological Laboratories and the scheme of work on ginning problems were examined by the Technological Research Sub-Committee.

The meeting also considered subjects relating to the improvement of cotton forecasts and the finding of wider markets for Indian cotton.

The first conference of scientific research workers on cotton in India was held on the 4th, 5th and 6th March, at Bombay, Sir Bryce Burt presiding. In the course of his remarks Sir Bryce said, "The Indian Central Cotton Committee has felt for some time past that there should be an opportunity for the discussion of purely scientific and technical matters in an atmosphere free from those administrative and financial considerations which are always in our minds at the Central Cotton Committee meetings. It is obvious that the many technical and scientific questions connected with cotton improvement should from time to time be discussed in a purely objective manner and from the scientific aspect. This meeting also gives us an opportunity of bringing together many of the junior cotton research workers who would otherwise have no opportunity of meeting each other."

The programme included reading of scientific papers, discussions on pests and diseases of cotton, and cotton technology. A visit was arranged for the Technological Laboratory at Matunga.

* * *

An **Ornithological Expedition** led and financed by Col. Richard Meinertzhagen, D.S.O., M.B.O.U., the eminent British Ornithologist of international repute and a specialist in Mallophaga, has been recently organised. Collections of birds are being made in various types of country in India, especially with a view to Mallophaga studies. After working at the Mulug camp in Hyderabad the expeditioners proceed to Bharatpur where some of the resident ducks and also the sandgrouse for Mallophaga studies, will be collected. Later, collections will be made around Khatmandu in Nepal and on the Manchar Lake in Sind. In early April the expedition will reach Kabul. The Afghan Government have extended permission and facilities for the expedition to enter and move about the country for their work. The principal object will be the collection of birds and the study of their ecology; they will also make botanical and entomological collections and also collect small mammals. The expedition will be in the field in Afghanistan from April to October. Col. Meinertzhagen has offered to take with the Expedition, Prof. Birbal Sahni, F.R.S., an experienced palæobotanist; it is anticipated that the study of palæobotanical material which will be collected there, would throw some light on Wegener's Theory of Continental Drift.

The Expedition consists of Col. R. Meinertzhagen, Mr. Salim Ali and two experienced skinners of birds and mammals and insect collectors.

* * *

Handbook on Timbers.—(His Majesty's Stationery Office, 1937. Price 1*s.* 8*d.*) A wealth of concise information on the properties and uses of some 36 species of timber grown in the United Kingdom is placed at the disposal of timber users and growers in this new *Handbook* of the Forest Products Research Laboratory.

The information results in part from a series of prolonged investigations undertaken by the Laboratory, and it amplifies and brings up to date the previous publication *The Uses of Home-Grown Timbers* issued in 1927.

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We congratulate Prof. S. G. Dhar, D.Sc. (Cal. & Edin.), Head of the Department of Mathematics, College of Science, Nagpur, on his being elected as the Fellow of the Royal Society of Edinburgh. We wish him all success in life.

* * *

New Laboratory for Applied Research.—At a cost of approximately \$40,000, Bausch & Lomb, Rochester, N. Y., have opened a new Laboratory for applied research, consisting of a series of Labortaory units devoted to research in the fields of metallurgy, experimental electro-plating, spectroscopy, photomicrography, and physical testing. A well-stocked library and a consulting room add to the facilities of the research staff.

Real advance has been made, according to Mr. Theodore B. Drescher, Director of the new Laboratory, in the perfection of cements for optical purposes; in the study of abrasives and polishing materials for optical glass; and in the investigation of the chemical and physical reactions on glass surfaces, induced by industrial gases, corrosive atmospheres and other atmospheric conditions. Further studies on these and many other subjects are planned.

One of the most interesting units is that in which Dr. James E. Wilson and his assistant, Vernon Patterson, are engaged in applying metallurgical equipment to the study of the structure of the steels and alloys used in industry. Physical tests are employed to check the quality and adaptability of materials.

Closely allied with this department is the laboratory for spectrographic analysis. In addition to testing spectrographic equipment built for laboratories in the United States, the application of spectroscopy to industrial problems, particularly in the field of metallurgy and ceramics has been recognised as an indispensable requirement.

One of the most interesting and valuable developments of the chemical laboratory has been in connection with a new transparent resin for use in protective glasses. The refinement of this commercial material for optical requirements has been an outstanding achievement. Sheets of this transparent substance have shown a light transmission efficiency of 90 per cent. The product has been found to have qualities superior to any materials available in the past as a laminating medium for lenses.

* * *

Announcements.

University of Madras.—"*The Ramanujam Memorial Prize*" of the value of Rs. 500 will be awarded for the best essay or thesis written on any branch of Mathematics, embodying the result of the personal investigations of the author and containing clear evidence of independent and original research. The prize is open to all persons born or domiciled in India. Intending competitors should forward their essays or theses so as to reach the Registrar *not later than* 1st December 1937.

All essays or theses for the above prize should be sent by Registrared Post addressed to the Registrar, University of Madras, University Buildings, Chepauk, Madras.

* * *

Certificate Course in Laboratory Arts.—The University of Madras has organised a Certificate Course in Laboratory Arts, to be conducted from the 15th April to 1st June, at the Physics Department, Presidency College, Madras, under the direction of Dr. H. Parameswaran, Professor of Physics. This course is meant specially for the benefit of the science staff in colleges such as Assistant Professors, Lecturers and Demonstrators.

The syllabus for the course comprises of lectures every morning from 10 to 11 on the laboratory arts of glass blowing, elementary machine drawing and blue print reading and practical work on metal, wood and glass as find applications in several laboratory instruments. Repair and maintanance of scientific apparatus, photography, silvering, vacuum work, electrical repairs and testing, laboratory organisation and accounts will also be taught in the course.

* * *

International Geological Congress—17th Session, Moscow, 1937.—The Organization Committee has notified that (*a*) All excursions before the Session of Congress will start on July 1st, 1937 from Moscow and only the Northern excursion will start from Leningrad. (*b*) All members of the Congress are expected to assemble in Moscow on July 20th; on that day arrangements will be made for a tour of inspection of the city of Moscow and in the evening the delegates of the Congress will be invited to an informal friendly meeting. The opening plenary meeting of the XVII Session of Congress will be held on July 21st. Duration of Session—10 days, of which the delegates of the Congress will be invited to spend 2 days in Leningrad. The Session of the Congress will close on July 29th. (*c*) On July 30th, all after-session-excursions will start; each excursion will last for 40 days, except the excursion to Nova Zembla, which will take 23 days, the excursion to Ural, 22 days and the excursion to places near Moscow, 3 days. (*d*) Before and after the Session of the Congress two special excursions will be arranged for members of the families of the delegates, these excursions will last 19 and 40 days respectively.

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We acknowledge with thanks receipt of the following:—

"Journal of Agricultural Research," Vol. 53, Nos. 9 and 10.

"Agricultural Gazette of New South Wales," Vol. 48, No. 1.

"Monthly Bulletin of Agricultural Science and Practice," Vol. 27, No. 12, December 1936.

"Journal of Agriculture and Livestocks in India," Vol. 7 No. 1, January 1937.

"The Philippine Agriculturist," Vol. 25, No. 9.

"Journal of the Royal Society of Arts," Vol. 84, Nos. 4392–4395.

"Biochemical Journal," Vol. 31, No. 1, Jan. 1937.

"Chemical Age," Vol. 36, Nos. 917–920.

"Journal of Chemical Physics," Vol. 5, No. 2.

"Journal of the Indian Chemical Society," Vol. 13, Nos. 11–12.

"Berichte der Deutschen Chemischen Gessellschaft," Vol. 70, No. 2.

"Journal de Chemie Physique," Vol. 34, No. 1.

"Experiment Station Record," Vol. 76, No. 1.

"Transactions of the Faraday Society," Vol. 33, Part II, February 1937.

"Forschungen und Fortschritte," Vol. 13, 4–5.

"Calcutta Medical Journal," Vol. 32, No. 2.

"Medico-Surgical Suggestions," Vol. 6, 1–2.

"Mathematics Student," Vol. 4, No. 3.

"Review of Applied Mycology," Vol. 16, Part 1.

"Journal of the Bombay Natural History Society," Vol. 39, No. 2.

"Nature," Vol. 139, Nos. 3508–3511.

"Journal of Nutrition," Vol. 13, No. 1.

"Research and Progress," Vol. 3, No. 1.

"Journal of Research, National Bureau of Standards," Vol. 17, Nos. 1 and 2.

"Lingnan Science Journal," Vol. 16, No. 1.

"Scientific American," Vol. 156, No. 2.

Government of India Publications:—

"Indian Trade Journal," Vol. 133, 1599-1602.

"Bulletin of Indian Industrial Research," 5.

ACADEMIES AND SOCIETIES.

Indian Academy of Sciences:

February 1937. SECTION A.—M. A. WALI AND M. C. TUMMIN KATTI: *Chemical Examination of the Constituents of* Hydrocotyle asiatica.—*Part I.* G. S. KASBEKAR AND A. R. NORMAND: *Reaction between Nitric Acid and Tin in Presence of Catalysts—Part I.*—The retarding effect of reagents like $FeSO_4$, $NaNO_2$, etc., and the accelerating effect of others like H_2SO_4 and $TiCl_3$ are studied. A. BALANKESWARA RAO: *Maxwell Effect in Some Organic Liquids.*—The experimental results of Sadron are re-checked against a corrected formula of Raman and Krishnan, and it is concluded that there is a general agreement excepting where complications due to association arise. K. SUBBA RAMAIAH: *Studies in Colloid Optics—I. Scattering of Light by Protein Solutions.*—Simultaneous measurements have been made of the depolarisation—with incident beam unpolarised, horizontally polarised and vertically polarised—and the intensity of light scattered by solutions of gelatin, casein and albumin, at various pH values. It is found that the intensity is a maximum and the depolarisation minimum at the iso-electric point. K. SUBBA RAMAIAH: *Studies in Colloid Optics—II. Scattering of Light by Silica Acid Sols and Gels.*—There is a continuous fall of ρ_h with time during gel formation indicating a continous growth in micellar size, even after gel formation is comlpete. ρ_v and ρ_u both pass through a minimum in slow setting and rapid setting systems, the minimum value being extremely small in the former case. N. JAYARAMAN: *The Mineralogy and Chemical Composition of Garnets from the Schist-Complex of Nellore.*—The variation in colour and other physical properties in the specimens are traceable to inclusions of quartz and ilmenite. Acicular inclusions of sillimanite have also been observed. V. SEETHARAMAN: *Differential Invariants for Path Spaces of Order 2.* P. NILAKANTAN: *X-Ray Studies of Wood, Lignin, and Wood-Cellulose.*—Proceeding from the most compact towards the least compact layer in the annual ring of teakwood there is a progressive disorientation of micelles in the fibre. Wood-structure near the region of knots and structural differences along tangential and radial directions have also been investigated. R. ANANTHAKRISHNAN: *The Raman Spectra of Crystal Powders. III.—Exchange Reactions: NH_4Cl and D_2O.*—The complete Raman spectrum of ND_4Cl is reported and compared with that of NH_4Cl. There is no evidence for HDO in the spectrum of water recovered from the exchange reaction photographed directly or as water of crystallisation in strontium chloride. M. A. GOVINDA RAU AND N. ANANTHANARAYANAN: *The Dipole Moment and Structure of Some Cyclic Anhydrides: Phthalic, Succinic and Citraconic Anhydrides.*—The moments are interpreted as due to a strong resonance structure which reverses the normal direction of moment to be expected from vectorial addition.

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Vol. V, No. 8, February 1937, pages 414–415, article entitled "Studies on Polyploid Plants" *for* "÷" occurring in the text to denote the total of chromosomes derived from various species *read* "+".

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Museums in India.

THE illustrated "Report upon the Museums and Art Galleries of India" recently issued by the Museums Association, as a result of the investigations conducted last year by Mr. S. F. Markham, Empire Secretary of that Association, and Mr. H. Hargreaves, former Director-General of Archæology in India, with funds from the Carnegie Corporation, deserves the careful attention of everyone who is interested in the raising through education of the cultural standard of the country. It contains not only the report proper, but also a 127-page directory of the museums, in which their scope, collections, publications, educational activities, staff and finance are carefully recorded. It is an outspoken document, often severely critical, but rich in valuable suggestions and by no means unmindful of the special difficulties that beset the museum movement in India.

One of the greatest difficulties is, of course, that of finance, for "on the whole of the Indian Museum Movement something less than Rs. 720,000 is spent per annum—less than is spent upon a single really good museum in any one of the great capital cities of Europe or America. The five richest Indian museums have a larger income than the remaining 100 put together, but even they with their *combined* incomes do not equal what is spent annually in Glasgow, Manchester, or a single one of the six large national museums in London. There is not a museum in India that can be regarded as adequately financed, and only a bare dozen can be considered as having finances even partially adequate to the task before them."

In British India about one twenty-eighth of an anna per head is spent annually upon museums, and in the Indian States only about the thirty-fourth of an anna, as compared with about $7\frac{1}{2}d.$ per head in countries like Great Britain and the U.S.A. But "The reasons for this

comparative poverty of museum finances are not far to seek. It must not be forgotten that India is essentially rural, and that although it has a population of 350,000,000 it has only 39 towns over 100,000 population compared with the 57 of the United Kingdom and the 74 of the U.S.A. Furthermore, the wealth per head is but a fraction of that of Europe or North America. Thus, whilst India as a country may be considered rich, the average individual lives at a scale so low that there is scarcely a European or North American equivalent. Whichever way one approaches the problem, however, it is evident that the finances of the museums of India whether in British India or in the Indian States, are much below those of almost any area in the world, and it is amazing what has been done, particularly at Bombay and Madras, on budgets below those of the principal provincial towns of the British Empire and the U.S.A."

In view of these facts, and of the difficulties under which the report shows curators to be at present working, the criticisms made lose much of their sting, but none of their importance.

The services that a museum should be rendering to the community for which it exists are classified as follows:—(1) Collection and preservation, (2) Interpretation, (3) Educational services. Concerning collection little is said, though it is made clear that in many museums much greater discrimination is required as to what is really worth preserving and what is not. Even as recently as 1935 the museum of one of the most educationally advanced cities in India—which shall be nameless here—"actually purchased 'A Monstrous Cow Calf'". But the account given of the way in which museum collections are—or rather, it seems, often are not—preserved bears out all too fully the conclusion "that many of India's most priceless treasures are not only deteriorating but are in fact disappearing from her museums" and that "while much needs to be done towards improving the curatorship of stone and metal exhibits, still more requires to be done towards improving the curatorship of textiles, books, natural history specimens and objects of wood and mixed materials. It is here that India has sustained and is sustaining her greatest losses. Carpets, uniforms, garments, manuscripts, maps, paintings, carvings and other minor evidences of India's past greatness are fast disappearing, to say nothing of the thousands of ethnological specimens that bear evidence of the lower stages of culture through which India has struggled."

Interpretation seems to be very much on a par with preservation. Labelling is apt to be woefully neglected or to be done mechanically instead of intelligently; guide-books are few and far between, as well as often being too highly priced with the result that they are apt to become hopelessly out of date long before the edition is sold out; and "only about twenty of the one hundred and five museums contribute anything towards an elucidation of their collections in terms of research publications, and only archæology receives anything like a fair share of attention. Thanks to the Presidency museums and those at Darjeeling and Nagpur, zoology is not entirely overlooked, but art, geology, ethnology, and particularly the arts and crafts of India are very much neglected, though the Jaipur catalogues do something to repair the omission in the case of the last named. Almost everywhere arms and armour were entirely unlabelled, and there seems to be little literature dealing with that subject, or at least little known to curators. Research in this direction would be of benefit to museums generally.....The poor labelling of most of the exhibits illustrating Indian arts and crafts reflects the want of complete and authoritative publications dealing with these, and there are very few museums which possess anything like a complete collection of the monographs on this subject issued from time to time by the various governments."

Educational facilities are even worse. Very few museums in India have ever organised systematic series of public lectures, and those that have attempted it seem to have discontinued the attempt for want of funds. "At many museums occasional lectures are given, but anything like an organised series of lectures for schools or students is apparently unknown in India, save at the Government Museum, Madras, "where in 1934–35 seventy teachers attended these demonstrations, and 4,516 pupils from some 130 schools in Madras and its suburbs were conducted over the Museum by their teachers.

It is unlikely that all of these 4,516 children will necessarily yearn to repeat the performance, but some certainly will, and for such the museum will be a known and friendly place."

The Report necessarily deals "mainly with the shortcomings of the existing museum service, which stands in need of complete awakening and reformation, and little has been said about the excellent work of those individual museums in which curators and committees are endeavouring to pursue a vigorous and progressive policy. Some of these are large museums possessing splendid materials and making good use of them, others are small museums devoting themselves to the illustration of local history or to some other definite purpose, some again, both large and small, possess collections of objects of great rarity and value. Unless the existence and work of these museums is realised, an unfair picture will be obtained of the actual state of affairs. Even so, a great effort and considerable expenditure are required to set the whole service in order and to supply deficiencies."

So much for the picture. What, in view of the difficulties at present inherent in the situation, can be done to rectify the very serious defects that it reveals?

The greatest needs are briefly: better facilities for and greater discrimination in collecting; a better understanding and use of the methods available for the initial preservation of specimens (including good taxidermy); better methods of display, and the segregation in reserve collections of all material not definitely helpful to public understanding of the subjects illustrated in the galleries; greater care of collections (especially such as are readily perishable) for which an adequate knowledge will be necessary of technical methods of checking any deterioration of which signs may appear, as well as constant vigilance; thorough and regular audit of specimens or at least of all those of great individual value; better labelling, including the use of explanatory labels as keys to different groups of specimens; adequate publications, including at least an interesting and intelligently written annual report from every museum detailing advances made during the year; cheap but interesting and well-written guide-books; and in every museum carefully organised educational services to schools in particular as well as to other interested bodies or persons.

In other words the prime necessity is a much higher general standard of curatorship, which can only be achieved by better trained curators with better status and pay, better facilities for their work and adequate opportunities for consultation with other curators through special conferences and occasional visits.

The qualifications required by a curator include, as the Report emphasises, a liberal education, administrative, literary and teaching ability, technical knowledge of various kinds and a real and inspiring enthusiasm for museum work. Such a combination is not easy to find, yet "Throughout India only a score of museums have what can be described as a full-time competent staff" while "At no less than one-third of the museums where the curatorial position is a full-time appointment the salaries are Rs. 100 a month or less, and at another third the salaries are Rs. 500 or below. These salaries are in sad contrast with those paid in the Dutch East Indies, Singapore and Ceylon." Comparatively few curators of Indian museums have, moreover, we believe had much real training in the curatorial side of their work, especially in the technicalities of effective conservation, having been selected mainly for their ability as archæologists, zoologists, etc., and all are severely handicapped by lack of time and effective assistance. "Archæological Chemists" are attached to the Archæological Survey and to a very few museums, some of whom are doing invaluable work, including research on the methods of preservation most suitable for various materials under tropical conditions. Some, on the other hand according to the Report, tend to confine their attention unduly to stone and metal—in which connection the designation "Archæological Chemist" comes in for criticism. Some curators, too, seem to expect these chemists to relieve them of all responsibility for preservation work. "And yet India can do well, for some of the sections in the museums at Bombay, Calcutta and Madras are of a very high efficiency, and the museums at Dehra Dun, Darjeeling, and the Archæological Museum at Gwalior, and the Sri Chitralayam at Trivandrum, show what work can be done by keen well-trained curators whose heart

is in their work, and who are not afraid to use their hands. This last phrase is fully meant, for one of the weaknesses of the Indian Museum Movement is the habit that has grown up of some officials passing on their duties to their subordinates."

Lastly, though the manifest advantages of the arts and sciences in India being fostered by Indians is clearly recognised, it is pointed out that the recent rapid replacement of European by Indian curators has one inherent drawback—the new men have much less personal touch than the old with countries in which the Museum Movement is more advanced than in India. "Thus, if the Indian curator is to keep abreast of his colleagues in other parts of the world, visits at not too distant intervals to other areas seem to be an absolute necessity." For this, as well as for visits to other museums in India, money will also be needed. "Finance is indeed the key to India's museum development; it is hopless to expect a great movement on fantastically low budgets."

In spite of the poverty already referred to of the average Indian individual, this fundamental problem of finance should not be insoluble. To expect India to spend anything like as much per head as England or the U.S.A. would clearly be ridiculous. But when neighbouring tropical countries like Ceylon, British Malaya and Java spend respectively a third, a half and a seventh of a penny per head annually on museums, surely India both can and should spend more than about a thirtieth of a penny. As a result of more adequate expenditure "The curatorship at Colombo, Singapore and Batavia is of a much higher level than that of the average Indian Provincial Museum; pests are kept down with a firm hand; labelling and arrangement will compare favourably with the best European models, and the research work is of a high order."

Further, with reference to the extreme rareness of private financial donations the Report stresses the fact that "This curious paucity of private benefactions cannot be due to any lack of fortune, for it is probable that a list of the hundred richest men in the world would include a dozen Indians".

It should therefore be possible for the necessary funds to be made available if those who administer them, both governments and wealthy individuals, can be brought to realise that "Unless there is a change in the near future, proof of India's cultural greatness in terms of handicrafts will disappear before our eyes and the historian of the future will have to go to Europe for evidence that centuries ago India could weave, carve, compose and create superb objects of art and industry. Consideration of what should be done by the authorities in India to preserve for posterity her priceless treasures and to interpret them more adequately to the world can no longer be postponed."

Money alone, however, solves no problems. How should it be used? Clearly every curatorial post should carry enough pay to attract really efficient and well-qualified men, who must further have adequate facilities for their work. Without this no museum can prosper for long, and the report rightly recommends in no uncertain voice that useless museums should be closed. The securing of such men alone as curators would in itself ensure an improvement in their status such as is also needed since "probably in no part of the world has the museum service less capacity for, or opportunity of, making itself heard in the corridors and lobbies of Government, or of drawing attention to its urgent needs. In all India it is nobody's business to advise governments on Museums generally. They may be good, but no one can praise them and secure additional grants: they may be bad, deplorably so, but it is no one's business to condemn."

Existing curators, however, even those that leave much to be desired, cannot simply be dismissed, nor would that be right. Even the most promising new man would, moreover, find it a matter of almost superhuman difficulty to retain his enthusiasm and keep himself up to date and his mind alive in isolation and "In no part of the world is the curator so isolated as in India". Means have therefore to be found for providing continuous help to curators in overcoming such difficulties.

In the chapter headed "Conclusions and Suggestions" the Report says: "It has been already shown that the Central and Provincial Governments are responsible for nearly half of the Indian museums and for almost all the large and important ones. If, therefore, any real and lasting improvement is to be effected it will fall to the Government of India to take the first steps. That

the Government of India has recognised its obligations in this matter is evidenced by the resolution issued by the Governor-General in Council on the 22nd of October, 1915, wherein it is recorded that 'he also desires to see the museums of India developed on scientific lines and anticipates much profit from the periodic conference of museum authorities'. We suggest, therefore, that the Government of India should create a special appointment of Inspector-General of Museums (for a period of at least three years) holding a position similar to that of the Educational Commissioner with the Government of India, and acting in an advisory capacity. Such an appointment in the Department of Education would emphasise the educational aspect of museums." While recognising that very few museums are directly supported from central revenues, all authorities should avail themselves of his services, since "They can no longer keep their museums in watertight compartments and expect efficiency". He "should have had a European Museum experience and a wide grasp of the problems of museum work, from conservation to exhibition, from administration to research." He should see that every museum receiving a Government grant has an efficient curator, should make periodic inspections to enable him to advise as to developments and as to the possible closing of less successful museums, as well as to issue an annual report on the Museum Movement as a whole. "There should, in fact, be a definite Government policy towards museums, based upon the fundamental idea that it is the duty of the Government to provide for students and to preserve for posterity collections of scientific and artistic material. To do this the maintenance of museums of unquestioned efficiency is essential."

Another recommendation of fundamental importance is "The revival of the Standing Committee on Museums and Museum Conferences and the provision of funds to meet the cost of the Committee, travelling allowances involved and the necessary printing". Periodical Museum Conferences at different museum centres would afford splendid opportunitues for curators to meet and intensify—in some cases perhaps renew—their interest, knowledge and enthusiasm, and might advantageously be held, we would suggest, in conjunction (but not simultaneously) with the meetings of the Indian Science Congress and the Orientalists' Conference in different years.

Many existing as well as future curators, moreover, will need scholarships and opportunities for special training, in the provision of which it is recommended that the proposed Inspector-General should also be concerned; and all will need funds for the purchase of necessary books if they are to carry out their duties efficiently. In this connection we should like to add a suggestion that the Governments, Central, Provincial and State, should agree to supply all their relevant monographs and serial publications, either free of charge or at some very small fraction of their published price, to every museum—and we would venture to add to every first grade college—in India, so long as they arrange to look after them properly. The country would thus obtain a wider use of the valuable books for the preparation and publication of which it pays, many of which we suspect at present remain unsold in the various presses for a considerable period. If this is the case the additional actual cost to the Governments concerned would be very small.

Other special recommendations, though of great importance are probably of less general interest. They relate to such matters as the need, already stressed above, for greater emphasis on the proper preservation of collections; more attention to the collection and proper preservation of important ethnological material, most of it extremely perishable, which is rapidly disappearing before the advance of modern civilisation; the imperative need for earthquake-proof buildings before the immense and valuable collections of the museums situated in the earthquake zone can be considered reasonably safe; the provision of a good museum in every town of 100,000 inhabitants; and the need for greater consideration being given to the education of the crowds of illiterates that visit the museums and cannot be reached through labels or books. In this last connection the Report remarks, "We feel that one of the first requirements of the Indian Museums Movement is the sympathetic study of the problem of the illiterate visitor. Throughout the world, and particularly in the United States and Europe, the most extensive enquiries have been made into

the psychological reactions of literate visitors to museums, and the recent investigations at the Buffalo Natural History Museum and others make it almost possible to predict how long a visitor will stand in front of a given case, and just which labels he will read; but as far as we can discover nobody has ever given more than a passing thought to the problem of the illiterate visitor and his education by means of adapted museums." Perhaps those who go out in charge of vans for agricultural or other propaganda in the villages may have suggestion on this point that might usefully be passed on to museum curators.

The needs are vast and the available resources of the country slender. We agree with the Report in thinking that the amount allocated by the country to museums could and should be very greatly augmented. We also remember, however, the substantial help that has come to many museums both in Europe and in the East from trust funds such as the one that has financed this survey. Now that the Report has shown not only how great but also how urgent is the need, may we not, in view of the extreme poverty of the average Indian, look to these funds to supplement in some measure the resources of the country in implementing its recommendations?

In conclusion, we commend the Report itself to the careful attention of all who are in any way interested in the preservation for future generations of India's cultural heritage, or in its present development, and not least to the various Governments. And we must heartily thank the two investigators for their valuable work, and the Carnegie Corporation for making it possible.

A Lecture to the Scientists.

We have recently read extracts of the speech addressed by Lt.-Col. R. S. Weir, Director of Public Instruction, U. P., to the National Academy of Sciences, India, at its Annual Meeting held on the 15th January. If the press has reported the address faithfully, we have no hesitation in saying that the Director's utterances are as amazing as uncalled for, and, proceeding from an Officer who directs and controls the educational destiny of one of the most progressive and enlightened provinces in India, they are fraught with incalculable mischief, if pursued to their logical conclusion. It must be remembered that the members and fellows of the Academy have dedicated their lives to the pursuit of scientific researches, and some of them occupy the foremost ranks among the International Scientists, and all of them have made significant contributions extending and enriching scientific knowledge. We are bewildered that, in such a distinguished company, the Director of Public Instruction should have indulged in cheap sneers at their work and achievements. Criticisms so flagrantly wide of the mark are not likely to affect the prestige and reputation of the Academy whose glittering record has earned for it esteem and recognition both in India and abroad. We propose to deal with some of the extracts of Lt.-Col. Weir's speech.

"The Universities get larger and larger, their machinery is overloaded with their third class students, and their fields of instruction are widened. Their libraries grow larger year by year. There is much running to and fro. But few men seem to have the time to ask why they are attending the University or to what end all this accumulation of knowledge is directed.

"The attention of the public has been very forcibly directed of late to the absence of a plan in our educational system. In these provinces the expenditure from public funds on secondary and collegiate education is twice the expenditure on primary education. In consequence the market is overloaded with educated young men, qualified in philosophy and economics while the illiterate peasant toils humbly in his fields."

Those who are intimately acquainted with the progress of Education in India and her growing educational needs for a proper readjustment of the people's social and economic conditions, favour not only the growth and expansion of the existing Universities, but also emphasise the need and desirability of establishing such educational foundations in increasing numbers. The prevailing criticism of our Universities is that they do not offer sufficiently wide and diversified courses of instruction, and that they are too conservative and prone to restrict their studies to formal subjects, almost ignoring the modern sides.

We are unable to understand why the Director is harsh on the third class students; probably he is unaware that success or

failure in an examination supply no standards by which the promise of the future may be estimated. Originality of thought or achievement cannot be measured by the same units as those we use in testing the knowledge of prescribed text-books. Academic distinctions need not necessarily imply success in public life. The Universities do not exist to produce only stars of the first magnitude; they can justify their existence if they fill the firmament with illumination emitted by stars great and small. Third class students have often proved capable and worthy citizens and have contributed to the richness of public life.

Surely the Director of Public Instruction knows that Government is the greatest employer in India. In fact all employers place a great premium on the university diplomas and degrees for admission to service. The moment the employers withdraw this qualification for admission, probably the universities will cease to get "larger and larger", and all the students will then migrate to institutions which offer promise of careers and obviously this new "machinery must soon become overloaded". It will be interesting to know what the Director's views are in respect of the unemployment problem of the educated young men.

The Head of the Education Department should have realised that the expenditure of public funds on the different grades of education is proportional to the standard and the end expected to be attained by them. Primary schools obviously do not need the equipment and staff usually provided for secondary schools, which require much less than the colleges where original investigations are carried on. These institutions are in a progressive scale, just as the department has a hierarchy of officers. Would Lt.-Col. Weir accept a lower rate of salary for the reason that "the illiterate peasant toils humbly in his fields", which he alleges as a ground for retrenching the expenditure on secondary and collegiate education, or would he have the peasant and the philosophy graduate exchange places?

The whole speech is based on ignorance. The Director suffers from loose thinking. We shall give one or two instances of both.

"A similar state of affairs seems to exist within the Universities—a lack of plan, of co-ordinated effort. There is no lack of funds—although Universities are always pleading poverty—and in the Budget ample provision is found for scholarships and research but in the direction of this provision things are not so satisfactory. There is no dearth of researchers. No lack of effort. But the result is largely an accumulation of educational lumber. The shelves of the libraries groan with papers that are of no use to anybody. The desire to see something in print rather than the desire to do something worth doing, something considered as contribution to a planned system, is responsible for the cluttering up of our laboratories with much useless material.

"Further I have no doubt that these research scholarships are a great temptation to young men who see no immediate opening in the world. The real spirit of the researcher is absent. Do these young men of to-day undergo difficulties and hardships, devise expedients, live dangerously, sacrifice anything or lack any comfort?"

Lt.-Col. Weir has manifestly a very queer concept of the meaning and influence of scientific research. He is confusing the accidental with the essential. No amount of poverty, hardship and self-sacrifice will produce the scientific spirit. It is born, and no born scientist is daunted by these circumstances when they confront him. Every school girl knows that scientific work is not inspired by any motive, and that the value of science is not to be measured by practical service, though its results might contribute to material prosperity. Every child knows that knowledge like most things has two sides, *viz.*, theoretical and practical, and that what is theoretical to-day may be used to-morrow for commercial gain or materialistic domination.

We have no doubt that if Col. Weir had been appointed to a research fellowship in any British University and had conducted a piece of original research, his language about the Indian Research Scholars would have been more restrained and better informed. It is perfectly ridiculous to maintain that the university budgets are prosperous, because they provide for a few scholarships, and it is equally ridiculous to say that "in the direction of this provision things are not so satisfactory", for the professors who initiate and direct the work of these scholars have by their labours earned for their universities a reputation as honourable and distinguished

as that enjoyed by any of the foreign seminaries of learning.

"The research scholar, flushed with the pride of his M.A. or M.Sc., potters around with some miserable question of whether the Huns were white, yellow or blue, peers through the microscope at the entrails of some inoffensive insect, proves that Kant could not have been serious when he wrote his *Kritik of Pure Reason*, and then unloads this stuff on a long suffering public."

"This is not real research and work of this type should be brought under control by the Academy. There is plenty of honest work to be done and the time and money spent on the present sterile research should be turned to better use."

"To what end should research be directed? Scientific knowledge has to be useful knowledge and not the sterile futile stuff that is piling up all over the world under the name research. Let the Academy show its approval of those who quietly and unostentatiously make their contribution to knowledge. Let it be frigid to the charlatan, the chatterbox, the politico-scientist. In other words let the Academy show its approval of honest work."

"And amid the numerous causes which the Academy may help let the foremost be that of serving mankind—India. To those who labour towards improving the conditions of life here, in India, let the Academy lend its full support. It is the duty of every one of us to remember that we are carried on the back of the peasant. We may administer, write, boil, bake, brew, teach or learn, work or idle but ultimately we must eat, and in eating we depend on the peasant. Then let our labours be directed to securing for the peasant, a better home, a better life, a better return for his labour."

"What I have said applies to all of us. We must get to work. Yet I learn that it is proposed in some quarters to limit the hours of teaching work of professors, of lecturers and of readers. One of my correspondents works out these proposed rules would limit the teaching of a professor to about ½ hour per day. Such regulations cast great discredit on the profession. They can be construed as exhibiting the worst features of trade unionism at its lowest ebb. Regulations of this type do much to foster the common belief and I shall be frank with you—that University posts are largely sinecures. And from the Universities this spirit of 'Ca Canny', this acceptance of limitation of labour, of insistence on free periods, has spread to and corrupted the entire educational system."

We have quoted this long passage in order to show the extent of ignorance of its author in respect of the history of the progress of scientific investigation and the amount of loose thinking which must inevitably follow poor understanding. Surely Col. Weir must know the achievements which resulted from Sir Ronald Ross's peering through the microscope at the entrails of the apparently inoffensive insects. The problem of elevating the status of the peasant belongs to sociology and economics, while his industry involves researches in the physical and biological sciences. Investigations into any aspect of rural life must at first be theoretical, and the application of this knowledge for its improvement forms the second stage of scientific work. It is well known that all industries have grown out of researches in pure science, and if such knowledge is to be treated as "sterile and futile", then obviously industries must be poor in standard and efficiency. If Col. Weir had taken more pains to think clearly and carefully, he would have been less caustic and more appreciative of the scientific work done in the Universities and the official departments. He wants the professors of the Universities to devote their time and intelligence to serve the cause of mankind in India by pursuing researches in useful knowledge, and at the same time he insists that they should be engaged in teaching all the hours of the week like the Rev. John Wesley in the School at Kingswood in 1750. Col. Weir has quoted from Louis Pasteur for the edification of his audience. If Pasteur had been working as the Rev. John Wesley did, would he have had time "to serve mankind"?

The whole speech is based on imperfect understanding of the functions of the different grades of education and of those who impart it, and on the complete misunderstanding of the purpose and significance of laboratory investigations. The only relieving feature of the address is that part in which Col. Weir professes a tender solicitude for the improvement of the peasant's lot, and the rest of it is amateurish.

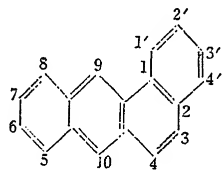
Cancer-producing Chemical Compounds.

By C. L. Hewett.

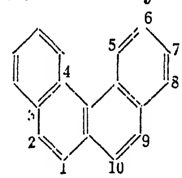
(*The Royal Cancer Hospital, London.*)

THE discovery of a group of chemical compounds having the power to induce malignant tumours in animals was the outcome of the recognition that coal tar has cancer-producing properties. The first experimental demonstration of this was due to Yamagiwa and Ichikwa[1] who, in 1915 produced cancer in the ears of rabbits by painting them with tar. Subsequent investigation of various tar fractions led Bloch and Dreifuss[2] to the view that the substance responsible for cancer was a high boiling neutral, nitrogen-free, picrate-forming substance. The production of strongly carcinogenic tars by the pyrolysis of isoprene or acetylene in an atmosphere of hydrogen[3] showed that a hydrocarbon could be responsible for the production of cancer and there was a strong presumption that the carcinogenic substance in coal tar was a hydrocarbon. A strongly carcinogenic product was also found[3] in the higher boiling fractions of the mixture obtained by the action of aluminium chloride on tetrahydronaphthalene.[4]

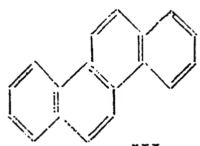
The observation in 1927 of Mayneord that the known carcinogenic mixtures were strongly fluorescent and each had a similar fluorescence spectrum with bands at 4040, 4270, 4540 Å (positions of short wave-length edges), resulted in the use of fluorescence spectrum as a guide in the isolation of the active material and in the selection of compounds likely to possess carcinogenic activity.[5] The fluorescence spectrum of 1 : 2-benzanthracene (I) was found to be very similar to those of a typical carcinogenic mixture, but the absolute wave-lengths differed, and in view of this a number of 1 : 2-benzanthracene derivatives were tested for activity by Kennaway and Hieger;[6] among these were 1 : 2 : 5 : 6-dibenzanthracene (IV) and its 3′-methyl derivative, prepared by the method of Clar.[7] These two compounds produced malignant tumours in the mice which were treated with them. 1 : 2 : 3 : 4-Dibenzanthracene, which was also tested in a slightly impure state, yielded only two tumours in 200 mice which had been treated with it over a period of 600 to 700 days.[8] 1 : 2-Benzanthracene itself showed very little activity.



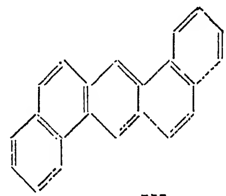
I



II



III



IV

A study of a series of 1 : 2-benzanthracene homologues has shown that carcinogenic

Compound	No of mice	Tumours	
		Epitheliomas	Papillomas
1 : 2-Benzanthracene	80	1	0
4-Methyl-1 : 2-benzanthracene	10	0	1
5-Methyl-1 : 2-benzanthracene	10	5	2
5-*n*-Propyl-1 : 2-benzanthracene	20	3	2
6-Methyl-1 : 2-benzanthracene	10	2	1
5 : 6-Dimethyl-1 : 2-benzanthracene	20	16	0
6 : 7-Dimethyl-1 : 2-benzanthracene	20	0	2
6-*iso*Propyl-1 : 2-benzanthracene	17	10	1
5 : 6-*cyclo*Penteno-1 : 2-benzanthracene	70	20	1
6 : 7-*cyclo*Penteno-1 : 2-benzanthracene	10	6	1

[1] Yamagiwa and Ichikawa, *Mitteil. med. Facultät, kaiser. Univ. Tokyo*, 1915, **15,** 295.

[2] Bloch and Dreifuss, *Schweiz med. Woch*, 1921, **2,** 1033.

[3] Kennaway, *Journ. Path. and Bact.*, 1924, **27,** 233; *Brit. med. Journ.*, 1925, **ii,** 1.

[4] Schrœter, *Ber.*, 1924, **57,** 1990.

[5] Hieger, *Biochem. Journ.*, 1930, **24,** 505.

[6] Kennaway and Hieger, *Brit. med. Journ.*, 1930, 250.

[7] Clar, *Ber.*, 1929, **62,** 350; see also Fieser and Dietz, *Ber.*, 1929, **62,** 1827.

[8] Cook, Kennaway, Hieger and Mayneord, *Proc. Roy. Soc.*, (B), 1932, **111,** 455.

activity is developed when an alkyl group is introduced into positions 5 or 6, or both in the molecule.[9,10]

Substitution in other parts of the molecule usually lessens the activity, thus 3′-methyl 1 : 2 : 5 : 6-dibenzanthracene is less active than the parent hydrocarbon. 2′ : 6-Dimethyl- and 3′ : 6-dimethyl-1 : 2-benzanthracene have given no tumours in mice.

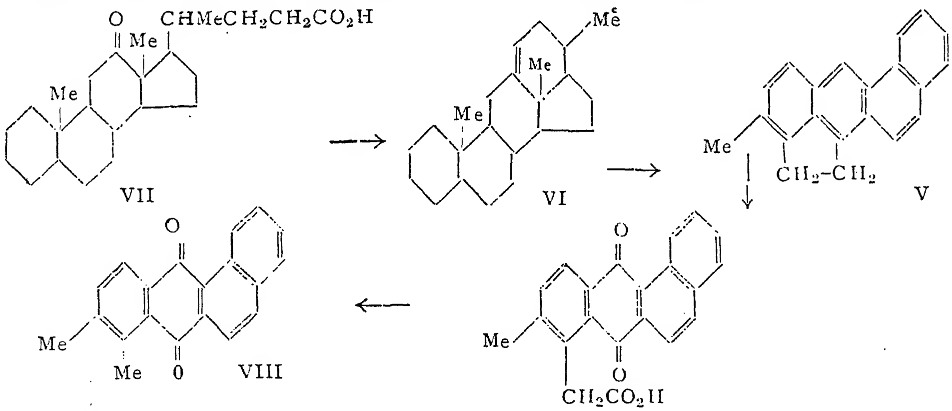
Experiments have been carried out with all the six possible aromatic hydrocarbons containing four six-membered rings.[10] In only one case was any evidence obtained of pronounced carcinogenic activity, 3 : 4-benzphenanthrene (II) producing 7 epitheliomas and 5 papillomas in 20 mice. The time of production is very long however, the first tumour making its appearance on about the 300th day. This is one of the few active carcinogenic compounds not related to 1 : 2-benzanthracene. In unpublished experiments it has been found that the 2-methyl derivative of 3 : 4-benzphenanthrene[11] produces epitheliomas in mice much more rapidly than the parent hydrocarbon.

Entirely negative results were obtained with triphenylene, naphthacene (3 : 4-benzanthracene) and 6-*iso*propylnaphthacene. 1 : 2-Benzanthracene gave only one epithelioma in 80 mice when applied to the skin. An extensive investigation of the action of chrysene (III), which Bottomley and Twort[12] claim to be active, has yielded three papillomas and one epithelioma in 290 mice using a specimen probably of coal tar origin. With pure synthetic chrysene in a series of 20 mice, 5 of which lived more than 440 days, one mouse died on the 853rp day bearing a large epithelial tumour which had appeared on the 711th day. This tumour showed some downgrowth but did not reach the superficial layer of voluntary muscle. No other mouse showed any tumour, hence the carcinogenic power of chrysene is of an extremely low order.

The three papillomas produced in 45 mice by pyrene may possibly have been due to a trace of impurity as the sample used was tinted slightly yellow.

Reduction of the ring system greatly reduces or destroys the carcinogenic activity; 9 : 10-dihydro-1 : 2 : 5 : 6-dibenzanthracene* has a very low order of activity and Schürch and Winterstein[13] have found that a tetrahydro derivative of 3 : 4-benzpyrene (a strongly active substance) produced no tumours.

The most active carcinogenic hydrocarbon known is methylcholanthrene (V), the cancer-producing properties of which were predicted by Cook[14] from its constitution as a 1 : 2-benzanthracene derivative with substituents in positions 5 and 6. The interest of methylcholanthrene lies in its preparation from deoxycholic acid, one of the acids of human bile.[15] It has also been prepared from cholic acid itself, the most abundant bile acid in man.[16]



[9] Cook, *Proc. Roy. Soc.*, (B), 1932, **111**, 485.
[10] Barry, Cook, Haslewood, Hewett, Hieger and Kennaway, *Proc. Roy. Soc.*, (B), 1935, **117**, 318.
[11] Hewett, *J.C.S.*, 1936, 596.
[12] Bottomley and Twort, *Amer. Journ. Cancer.*, 1934, **21**, 781.
* Evidence of the absorption spectrum showed that the sample used was probably contaminated with 1 : 2 : 5 : 6-dibenzanthracene. [Mayneord and Roe, *Proc. Roy. Soc.*, (A), 1935, **152**, 299.]
[13] Schürch and Winterstein, *Ztschr. Physiol. Chem.*, 1935, **236**, 79.
[14] Cook, *Proc. Roy. Soc.*, (B), 1933, **113**, 277.
[15] Wieland and Dane, *Ztschr. Physiol. Chem.*, 1933, **219**, 240; Cook and Haslewood, *Chemistry and Industry*, 1933, **38**, 758.
[16] Fieser and Seligman, *Journ. Amer. Chem. Soc.*, 1935, **57**, 228, 942.

The high activity of methylcholanthrene is shown not only by the early appearance of tumours, but also by the high percentage of animals which develop tumours. In one series of 20 mice, 18 tumours were obtained within 180 days. A tumour has also been obtained as early as the 31st day.

The conversion of a bile acid into a carcinogenic compound establishes a link between naturally occurring compounds and cancer, and is of interest since all the reactions employed in the preparation of methylcholanthrene are of a type known to occur in the human body.

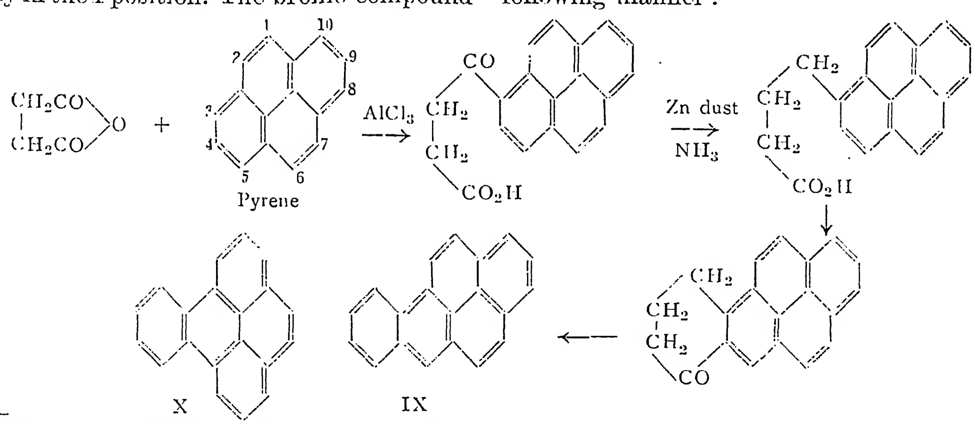
The hydrocarbon is prepared by the simultaneous dehydrogenation and elimination of two quaternary methyl groups of dehydronorcholene (VI), a product obtained by Wieland and Schlichting[17] by the elimination of water and carbon dioxide, by pyrolysis, from 12-ketocholanic acid (VII). Its constitution has been determined[18] by degradation to 5 : 6-dimethyl-1 : 2-benzanthraquinone (VIII) and further to 1 : 2 : 5 : 6-anthraquinonetetracarboxylic acid, both of which were identified by comparison with synthetic specimens.

The synthesis of methylcholanthrene was carried out in 1935 by Fieser and Seligman[16] by a method involving an Elbs' pyrolysis. The parent hydrocarbon, cholanthrene, has now been prepared by four different methods.[19, 20, 21] The most suitable method for preparing the hydrocarbon in quantity depends on the fact that 2-alkylnaphthalenes brominate mainly in the 1 position. The bromo compound obtained from 1-(2′-naphthyl)-hydrindene was converted, by the action of carbon dioxide on the Grignard compound, into corresponding carboxylic acid. Dehydration of this acid with strong sulphuric acid gave an anthrone which passed into cholanthrene on reduction.

Cholanthrene itself is a very active carcinogenic hydrocarbon. It has given 28 tumours of the skin in 50 mice, the first tumour appearing after 52 days and 11 after 110 days.[22] This hydrocarbon showed high activity in producing sarcomas when injected in the crystalline state.[23]

Before the discovery of methyl cholanthrene, it was noticed that certain coal tar pitch fractions contained a substance which was more active than any pure compound then known. Hieger[24] set to work to isolate the active constituent by a method of fractional distillation and crystallisation, using the characteristic fluorescence spectrum as a guide. From the high boiling fractions he obtained, after removal of acids and bases, an active material which gave a sparingly soluble picrate. The picrate decomposed to give a crystalline hydrocarbon mixture, which still retained the characteristic fluorescence spectrum to an enhanced degree.

From this crude hydrocarbon mixture was obtained a pure hydrocarbon by many crystallisations of the picrate.[25] This was shown to be 3 : 4-benzpyrene (IX) by comparison with a specimen synthesised in the following manner :—



X IX

[17] Wieland and Schlichting, *Ztschr. physiol. Chem.*, 1925, **150**, 273.
[18] Cook and Haslewood, *J.C.S.*, 1934, 428.
[19] Cook and Haslewood, *J.C.S.*, 1935, 767, 770.
[20] Cook, Haslewood and Robinson, *J.C.S.*, 1935, 667.
[21] Fieser and Seligman, *Journ. Amer. Chem. Soc.*, 1935, **57**, 2174.
[22] Cook, *Ber.*, 1936, **69**, 46.
[23] Shear, *Amer. Journ. Cancer*, 1936, **26**, 322.
[24] Hieger, *J.C.S.*, 1933, 395.
[25] Cook, Hewett and Hieger, *J.C.S.*, 1933, 396.

The isomeric 1 : 2-benzpyrene (X) which was also isolated from the same crude fraction, had very little, if any, carcinogenic activity.

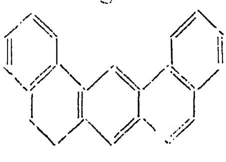
The fluorescence of 3 : 4-benzpyrene is so intense that it can be detected to the extent of one part in ten millions in solution. The pure hydrocarbon will produce tumours in mice in as little as 90 to 100 days,[10] and is now used in laboratories for the purpose of producing experimental cancer. In a series of 100 mice, 47 epitheliomas and 11 papillomas have been obtained.

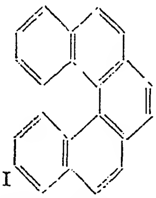
The absorption spectrum of 3 : 4-benzpyrene is definitely of the 1 : 2-benzanthracene type, although some features of the pyrene spectrum may be detected.

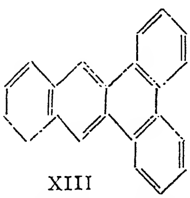
Winterstein and Schön[26] have shown that 3 : 4-benzpyrene is present in the higher boiling fractions of coal tar in relatively high amounts.

Some details of the original synthesis of 3 : 4-benzpyrene have been improved by Fieser and Fieser[27] and by Winterstein, Vetter and Schön,[28] with consequent increase of yield. The 3′-methyl derivative has not produced any tumours after 270 days.[13]

Of the 15 possible hydrocarbons containing five condensed benzene rings, only 12 are as yet known and these have all been tested on mice for carcinogenic activity. Of these 1 : 2 : 5 : 6-dibenzanthracene and 3 : 4-benzpyrene are the only two which have shown pronounced activity. 1 : 2 : 7 : 8-Dibenzanthracene (XI) has given 1 epithelioma and 3 papillomas in 20 mice in an experiment lasting over 2 years and 3 : 4 : 5 : 6-dibenzphenanthrene (XII) has given two transient tumours. Pure 1 : 2 : 3 : 4-dibenzanthracene (XIII) gave no tumours in an experiment in which the last mouse died on the 487th day. The other hydrocarbons were all negative.

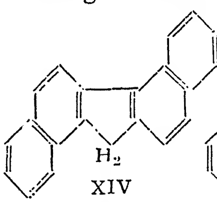

XI

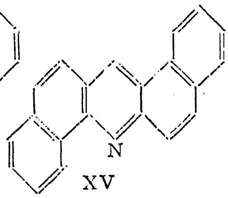

XII

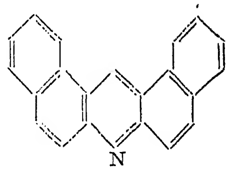

XIII

Morton, Clapp and Branch[29] claim to have produced malignant tumours with s. triphenylbenzene and tetraphenyl methane.[30] 20 per cent. of the mice gave sarcomas in 250 days when injected *sub cutem* (0·5 per cent. in sesame oil) with triphenylbenzene. Tetraphenylmethane applied to the skin of mice gave epitheliomas after 319 days in one strain of mice, but not in another. The order of activity must, therefore, be very low.

Experiments carried out with compounds which resemble the carcinogenic benzanthracene hydrocarbons in molecular structure have shown that 1 : 2 : 5 : 6-dibenzfluorene (XIV), in which the central six-membered ring of 1 : 2 : 5 : 6-dibenzanthracene has been replaced by a five-membered ring, has given a small number of epitheliomas in mice after about 1 year.[22] Positive results have also been obtained with a number of heterocyclic compounds of structure analogous to these two hydrocarbons. 1 : 2 : 5 : 6-Dibenzacridine (XV) has a slight activity and 3 : 4 : 5 : 6-dibenzacridine (XVI) a rather greater activity, 11 epitheliomas and 2 papillomas being obtained in 40 mice, although the time required is nearly twice as long as that required by 1 : 2 : 5 : 6-dibenzanthracene.[10,31] Replacement of the second meso carbon atom by nitrogen leads to loss of activity.


XIV


XV


XVI

Sasaki and Yoshida[32] obtained tumours of the liver and papillomas and at least one carcinoma of the bladder in rats receiving *o*-aminoazotoluene (5 per cent. in olive oil) in their food (1 mg. of azo compound in one g. of food). More recently Otsuka and Nagao[33] used the deaminated product, namely 2 : 3′-azotoluene, and obtained tumours of the bladder in a high percentage of the rats. This result is of considerable interest in connection with the abnormally high incidence of cancer of the bladder among workmen engaged in the manufacture of coal tar dyes and intermediates.

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[26] Winterstein and Schön, *Naturwiss.*, 1934, **22**, 237.
[27] Fieser and Fieser, *Journ. Amer. Chem. Soc.*, 1935, **57**, 782.
[28] Winterstein, Vetter and Schön, *Ber.*, 1935, **68**, 1079.
[29] Morton, Clapp and Branch, *Sci.*, 1935, **82**, 134.
[30] Morton, Branch and Clapp, *Amer. Journ. Cancer*, 1936, **26**, 754.
[31] Rondoni and Corbellini, *Tumori*, 1936, **10**, 106.
[32] Sasaki and Yoshida, *Virchow Arch.*, 1935, **295**, 175.
[33] Otsuka and Nagao, *Gann*, 1936, **30**, 561.

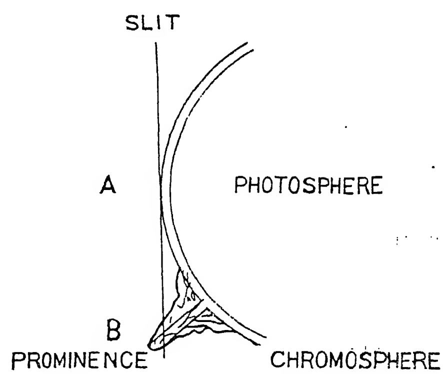
LETTERS TO THE EDITOR.

Oxygen in Solar Prominences.

At the total eclipse of 1925 Curtis and Burns[1] observed the infra-red O triplet as a single line in the chromospheric spectrum and stated that "it is very strong at low levels and weaker at higher levels, though faintly present in a high prominence".

Since one of us showed in *Kodaikanal Observatory Bulletin*, No. CVII, that it was possible to observe the O triplet in the chromosphere in full daylight, it seemed desirable to examine whether the O triplet could be seen reversed as bright lines in prominences also without an eclipse. It would be necessary to observe near the base of a prominence for the sake of obtaining sufficient intensity, and yet we must be able to prove that light from the chromosphere did not reach the slit at any time during the exposure.

In order to ensure that any effect observed was really due to a prominence and not to the chromosphere, it was arranged that the slit was tangential to the sun at a point near the prominence as illustrated in the figure. The guiding of the sun's image, which was controlled by visual observation of the H_α line, was so arranged that at the point A the chromosphere was either just on or just off the slit during the whole period of exposure. The distance AB was large enough that the chromosphere could



not reach the point B without photospheric light hopelessly fogging the plate at the point A.

The sky background, of course, always shows the O triplet as dark lines along the whole length of the slit due to the scattered sunlight, and for reversals to be seen as bright lines they must be stronger than this background spectrum. In no prominence observed hitherto has the O triplet been strong enough for this, but we have photographed many examples where the

O triplet partially reversed at the point B, *i.e.*, the dark lines of the O triplet at this point are markedly fainter than in the sky spectrum due to faint bright reversals in the prominence. None of these examples are suitable for reproduction but we regard the partial reversal seen in many examples at the point where the prominence is on the slit as demonstrating the existence of O in prominences. The distance AB is a measure of the height of the observed point in the prominence, and we have obtained partial reversals of the O triplet in prominences at a height of 10″ above the upper surface of the chromosphere.

The presence of O in prominence is another blow to the theory of their being supported by radiation pressure, for this makes still another element present in far greater abundance than Ca^+ on which alone can radiation pressure be appreciable.

We also attempted to photograph reversals of the O triplet in flocculi on the disc but have not hitherto been able to obtain convincing evidence.

T. ROYDS.
A. L. NARAYAN.

Kodaikanal Observatory,
March 10, 1937.

[1] *Publications of the Alleghany Observatory*, 1925, **6**, 95.

Effect of Temperature on the Wing Accompanying Rayleigh Scattering in Liquids.

RECENTLY Bhagavantam and Rao[1] have reported that there is a considerable weakening in the absolute intensity of the wing accompanying the Rayleigh scattering in benzene as we pass from the vapour to the liquid state. In an attempt to investigate this phenomenon more fully and to follow it up by stages, a study is made of the λ 4358 Rayleigh line in the liquid at different temperatures. The scattered spectrum of benzene contained in an exhausted and sealed pyrex glass tube is recorded once at the laboratory temperature and again at 210° C. under the same conditions of illumination, slit width, etc. The times of exposure are so adjusted that the intensity of the vibration line 990 is nearly the same in both pictures. The liquid is under a pressure of about 18 atmospheres at the higher temperature but the tube is specially made out of thick-wall glass so as to withstand the pressure. In Fig. 1

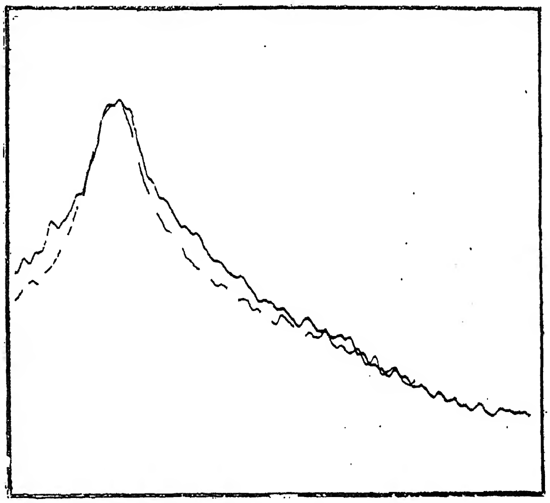


Fig. 1.

which is a microphotometric record of the λ 4358 line, broken curve relates to the low temperature whereas the continuous curve relates to the high temperature. The following conclusions are drawn from Fig. 1. At higher temperatures the extent of the wing does not alter, there is no increase in intensity in the external portions of the wing and the wing confined between 20 and 50 wave-numbers from the centre shows a marked increase in intensity.

Amongst others who have worked on similar lines, mention may be made of Gross and Vuks[2] who have studied this problem in the case of diphenyl ether. The extreme temperatures used by them are 18° C. and 250° C. and the results obtained by these authors are entirely similar to those reported in the present investigation. Veerabhadra Rao,[3] however, found that the intensity of the wing in all regions remains unchanged with increasing tempreature. This is evidently due to the fact that he has not heated the liquids beyond their boiling points and in the case of benzene the range adopted by him, namely, 30 to 80° C., is particularly narrow. Sirkar and Maiti,[4] on the other hand, obtained entirely different results as they found a distribution of intensity in the wings of liquid benzene similar to that obtained in gases both at the room temperature and 210° C. These

results are not confirmed by other investigators.

The results of Gross and Vuks on diphenyl ether as well as those of the author in benzene indicate that the liquid wings generally consist of two distinct parts which behave differently on heating. The outer portions possess features characteristic of the vibrational Raman scattering as they exhibit no increase in intensity when conditions are so arranged that the intensity of the vibrational Raman lines is kept constant. On the other hand, the intensity of the wing in regions closer to the centre increases under similar conditions suggesting that it is of a different origin. The increase may reasonably be correlated with the fact that the effective anisotropy of the liquid molecules increases with increasing temperature.

K. Bapayya.

Department of Physics,
Andhra University,
Waltair,
April 1, 1937.

1 *Proc. Ind. Acad. Sci.*, 1937, **5**, 18.
2 *Jour. d. Phys.*, 1935, **6**, 457.
3 *Proc. Ind. Acad. Sci.*, 1934, **1**, 274.
4 *Ind. Jour. Phys.*, 1934, **9**, 323.

Diamagnetic Susceptibility of Heavy Water.

The values for the diamagnetic susceptibility of heavy water (D_2O) obtained by different workers, do not agree among themselves.[1] A sample of 99·5 per cent. heavy water being available in the laboratory, its diamagnetic susceptibility was determined, employing Gouy's method. Full details of the apparatus used are described in a paper dealing with the diamagnetic susceptibility of formic and acetic acid solutions, to be published shortly elsewhere. Calibration experiments carried out with conductivity water, benzene and acetone, gave values for the constant which agreed to within 0·5 per cent. After correcting for the presence of ordinary water, assuming linear variation with percentage concentration, the mass susceptibility of pure heavy water was found to be $0{\cdot}638 \times 10^{-6}$ at a temperature of 29°C. This value is in close agreement with those of Cabrera and Fahlenbrach[2] and Trew and Spencer[3,4] but differs from the value found by Hoar[1] by about 1·5 per cent. The values obtained by different workers are given below :—

Author	% of D_2O employed	$-X \times 10^6$
Hoar	99·2	0·648 ± 0·004
Selwood and Frost[5] ..	92·0	0·644
Cabrera and Fahlenbrach ..	99·0	0·637
Trew and Spencer ..	99·2	0·637 ± 0·001
Authors	99·5	0·638

Our thanks are due to Norsk Hydro-Electric Kvoelstofaktieselskab, Oslo, for supplying free of cost the sample of heavy water used for these measurements.

V. Nehra.
M. Qureshi.

From the Department of Chemistry,
Osmania University,
Hyderabad (Dn.),
April 8, 1937.

1 Hoar, *Nature*, 1936, **137**, 497.
2 Cabrera and Fahlenbrach, *Naturwiss.*, 1934, **22**, 417.
3 Trew and Spencer, *Nature*, 1936, **137**, 706.
4 Trew and Spencer, *Ibid.*, 1936, **137**, 998.
5 Selwood and Frost, *J. Amer. Chem. Soc.*, 1933, **55**, 4335.

Estimation of Rice Yields by Sampling.

The estimation of yields of crops from field experiments by means of random sampling of the plots, instead of harvesting them whole is becoming increasingly popular in England. Studies enunciated by Clapham[1] and further developed by Kalamkar,[2] Clapham[3] and Yates and Zacopanay[4] have done much to popularise as well as to standardise the mode and apparatus of conducting analysis by the sampling technique. In America, Immer[5] has utilised sampling methods in studying sugar content of sugar-beets. Prior to the development of the random sampling method, Hubback[6] determined yield of rice by sampling on a very extensive scale in Bihar and Orissa. As there are possibilities of the random method becoming popular in India we considered it of interest to report briefly our studies in rice.

In the season of 1936 a number of rice fields in the vicinity of Karjat were sampled. For sampling, plots of 33′ × 33′ (1/40th of an acre) were first marked out in the rice fields. Each plot was further sub-divided, north to south, in 3 sub-plots and from each sub-plot 3 samples were taken at random. There were therefore 9 samples from each plot. The sampling unit was 3′ × 3′. The number of bunches and number of ears in the unit area were also recorded. After sampling, the remaining plot was harvested and yield of grain and straw of the whole plot determined. Altogether 41 plots were sampled, but data on 39 plots only were available, as yields of two plots were mixed up inadvertantly.

The analysis of yields of the plots indicated that in a few cases the division into sub-plots was advantageous, while in most cases the variance between sub-plots (D.F. 2) was smaller than within sub-plots (D.F. 6). The pooled estimate of variance is shown in Table I.

TABLE I.

Analysis of variance of sampling yields.

Due to	D.F.	Variance
Plots	38	482·84
Sub-plots	78	31·81
Samples	234	44·07

It will be seen that the variance due to "between plots" is much greater than that "between sub-plots" or to that "between samples", indicating great soil variability from plot to plot. The plot error per sampling unit is 21·97 or 63·30 per cent. of the mean and for the mean of 9 such sampling units the plot error is 21·10 per cent. The sampling error per sampling unit is 6·33 or 19·14 per cent. and for the 9 samples it is 6·38 per cent.

The "non-sampling" error, *i.e.*, the error if the whole area had been sampled, comes to 20·20 per cent. of the mean while the actual, as obtained from the actual yields of the whole plots, is 23·06 per cent. Thus the agreement between the two is good.

The mean yield per sampling unit was 34·69 quarter ounces as compared to 34·38 calculated from the total harvest. The correlation between the sampling yield per plot and that obtained by total harvest is 0·866. The sampling technique used by us furnished 92 per cent. of the total information. The detailed account of the experiment and its significance will appear elsewhere.*

B. S. KADAM.
R. J. KALAMAR.
V. K. PATANKAR.

Karjat,
March 18, 1937.

[1] Clapham, *Jour. Agric. Sci.*, 1929, **19**, 214.
[2] Kalamkar, *Jour. Agric. Sci.*, 1932, **22**, 783.
[3] Clapham, *Jour. Agric. Sci.*, 1931, **21**, 366 ; 376.
[4] Yates and Zacopanay, *Jour. Agric. Sci.*, 1935, **25**, 545.
[5] Immer, *Jour. Agric. Res.*, 1932, **44**, 633.
[6] Hubback, *Agric. Res. Inst. Pusa Bulletin*, 1927, No. 166.

* Thanks are due to Dr. L. A. Ramdas, Agricultural Meteorologist, Poona, for allowing one of us (R. J. Kalamkar) to co-operate in the investigation.

Fibrous Tourmalines from the Mysore State.

A FEW samples of tourmaline which were kindly presented to the author by the Director, Mysore State Geological Department, formed the material for investigation. Some of the specimens presented a distinctly fibrous structure. A chemical analysis of these specimens was, therefore, undertaken with a view to find out the difference, if any, in the chemical nature of this fibrous mineral from the ordinary crystalline varieties of tourmaline. The results obtained are given in Table I.

CHEMICAL COMPOSITION OF THE SPECIMENS.

Method of Analysis.—The usual methods employed for investigation of tourmalines were studied with a view to ascertain those most suitable for the determination of boron and fluorine. The methods employed were as follows :

The method devised by Gooch[1] of distilling off the boron with methyl alcohol and weighing as calcium borate was tried with synthetic mixtures of known proportions of silica, boric acid and calcium fluoride and was found to yield accurate results. This method was therefore adopted.

Fluorine was determined by the lead chlorofluoride method of Hoffman and Lundell.[2]

Alkalies were determined by the usual Lawrence-Smith method, but the residue after removal of ammonium salts was evaporated with methyl alcohol to free it from any borate that might possibly be present.

Water was determined by heating the mineral placed in a porcelain boat in a combustion tube, employing the usual precautions and collecting the water obtained in a weighed calcium chloride tube. The results obtained are given below:

TABLE I.

Specimen	A	B	C	D
	%	%	%	%
SiO_2 ..	34·64	34·00	33·20	35·38
TiO_2 ..	0·35	0·52	0·24	0·80
FeO ..	8·00	9·88	11·63	12·20
Al_2O_3	38·90	38·28	41·54	34·56
CaO ..	0·36	1·59	1·53	1·36
MgO ..	3·39	5·74	0·59	2·48
Na_2O ..	3·70	0·50	1·53	1·16
H_2O ..	0·90	1·00	1·00	1·76
F ..	n.D	n.D.	nil	0·33
B_2O_3 ..	9·1	8·01	8·00	9·90
MnO ..	nil	nil	0·02	nil
	99·34	99·52	99·28	99·93

Specimen A is a black variety of crystalline tourmaline occurring as individual crystals. An analysis of this sample is inserted here with a view to compare this with those of B, C and D, which represent various tages from a semi-fibrous to a completely fibrous variety of tourmaline. It appears from the above analysis, that the chemical composition of the fibrous tourmalines is not very different from that of the ordinary crystalline types, indicating that the fibrous structure may not be due to any important change in the chemical composition of the mineral. This view is, however, purely tentative as the specimens examined are not from the same locality. Further work in this direction is in progress and an investigation of the crystal structure of the mineral by X-rays is also being conducted in the Physics Department of this Institute.

The author wishes to gratefully acknowledge the constant help and guidance received from Dr. K. R. Krishnaswamy during the progress of this work. Thanks are also due to the Director, Mysore State Geological Department, for the kind gift of the above specimens.

K. Y. ŚREENIVASA IYENGAR.

Department of General Chemistry,
Indian Institute of Science,
Bangalore,
March 1, 1937.

[1] *Am. Chem. Jour.*, **9**, 23.
[2] *Bureau of Standard Jour. of Research*, 1929, **3**, 581.

A Note on the Development of the Embryo-Sac in *Phyllanthus niruri* Linn.

A monosporic embryo-sac of the 4-nucleate type is known at present in three families: Oenotheraceæ (all genera except *Trapa*[1]), Euphorbiaceæ (*Codiæum*, *Ceramanthus* and *Glochidion*[2]), and Liliaceæ (only *Clintonia borealis*[3]). Recently the same type of development was reported by Miss Parks (1935)[4] in *Commelinantia Pringlei* and *C. anomala*, but her statements do not at all appear to be convincing and other members of the Commelinaceæ are known to have the normal type of embryo-sac. Kusano's (1915)[5] observations on *Gastrodia elata* also demand a revision.

The ephemeral nature of the antipodals (cells or nuclei) has misled several authors to imagine that they are not formed at all and that they were dealing with genuine 5-nucleate embryo-sacs with only an egg apparatus and two polar nuclei. Thus, Rutgers (1923)[6] believed that there were only 5 nuclei in the embryo-sac of *Moringa oleifera* while Puri (1934)[7] has now demonstrated that all the eight are formed. Haeckel (1930)[8] likewise originally failed to observe the antipodals in *Sisyrinchium anceps* but was able to detect them afterwards.[9] Among cases of this kind which deserve reinvestigation, we may specially cite the following: *Garcinia Kydii* and *G. Treubii* (Treub, 1911)[10] *Monophyllæa Horsfieldii* (Oehlkers, 1923),[11]

Chamædorea concolor (Suessenguth, 1920)[12] and *Linaria genistæfolia* (Persidsky, 1934).[13] The last-named author makes the ambiguous statement that the antipodals are apparently not formed at all!

Of the Euphorbiaceous plants supposed to have a 4-nucleate embryo-sac by Arnoldi (1912)[2], *Codiæum variegatum* has already been shown to be normally 8-nucleate by Lundberg (1931)[14] and may be struck out of the list. The mistake was evidently due to the fact that the antipodals are very ephemeral and polar fusion takes place early. The designation "*Codiæum*-type" of embryo-sac, used by Palm (1915)[15] and Wettstein (1935) has now to be definitely discarded in favour of Schnarf's "*Oenothera*-type".[16]

Our own investigations on *Phyllanthus niruri* show that the primary parietal cell is cut off in the usual way and the megaspore-mother cell becomes covered by several layers formed by its divisions. It undergoes the usual reduction divisions and produces a tetrad of megaspores or a row of three cells of which the lower two are megaspores and the upper an undivided dyad cell. Here we wish to point out that a row of "two" or "three megaspores", often described in embryological literature on the embryology of Gymnosperms and Angiosperms, is theoretically impossible. Megaspore formation can be said to be over only after both the reducing divisions have taken place. The two cells formed after the first reduction division are dyad cells and *not* megaspores; when there is a row of three cells at the end, one *must be* an undivided dyad.

In every case the chalazal cell was found to function and its nucleus undergoes the usual three divisions to form 8 nuclei arranged in two quartets. A favourable slide showed all the four spindles of the last division and this leaves no doubt that the development is perfectly normal. Indeed, on looking over the literature on the subject, we found later that Modilewski (1910)[17] also figured an octo-nucleate embryo-sac in *P. angustifolius*, although he failed to observe all the stages leading to its origin.

Arnoldi (1912)[2] makes no mention of the particular species of *Ceramanthus* (= *Phyllanthus*) which he investigated, but in view of the observations reported here, it is hardly to be doubted that his plant was also normal and he overlooked the antipodals due to inadequacy of material of the right stage. The same may perhaps be said of *Glochidion*, which, however, still remains to be reinvestigated.

An interesting feature in the ovule of *Phyllanthus* is the presence of a nucellar beak of the type found by Miss Lyon (1898)[18] in *Euphorbia corollata*. The obturator is of common occurrence in the family and is present here also.

As pointed out by one of us (Maheshwari, 1937) it is possible to place a different and perhaps more correct interpretation on Smith's (1911)[3] figures of *Clintonia borealis*, which would leave the Oenotheraceæ as the only family having a monosporic tetranucleate embryo-sac. And, this has been found to be such a constant and characteristic feature here, that *Trapa*, which is the only exception, may rightly be kept apart (on embryological grounds too!) in a different family, the Hydrocaryaceæ.

P. MAHESHWARI.
O. R. CHOWDRY.
Berlin,
February 24, 1937.

1 Maheshwari, P., *A Critical Review of the Types of Embryo-Sacs in Angiosperms* (in the press).

2 Arnoldi, W., *Trav. Mus. Bot. Acad. St. Petersbourg*, 1912, **9**, 136.

3 Smith, R. W., *Bot. Gaz.*, 1911, **52**, 209.

4 Parks, M., *Bull. Torr. Bot. Club*, 1935, **62**, 91.

5 Kusano, S., *Jour. Coll. Agri. Imp. Univ. Tokyo*, 1915, **6**, 7.

6 Rutgers, F. L., *Ann. Jard. Bot., Buitenzorg*, 1923, **33**, 1.

7 Puri, V., *Proc. Ind. Acad. Sci.*, (B), 1934, **1**, 279.

8 Haeckel, J., *Flora*, 1930, **125**, 1.

9 Private communication to one of us (P. M.) during the course of a personal talk in Germany in February, 1937.

10 Treub, M., *Nouv. série des recherches. Ann. Jard. Bot. Buitenzorg*, 1911, **24**, 1.

11 Oehlkers, F., *Beih. Bot. Centralbl.*, 1923, **39**, I Abt., 128.

12 Suessenguth, K., Diss. München, 1919.

13 Persidsky, D. J., *Bull. Jard. Bot. Kieff*, 1934, **17**, 11 (In Russian with English summary).

14 Lundberg, F., *Bot. Not.* (*Lund.*), 1931, 346.

15 Palm, Bj., "Studien ueber Konstruktionstypen und Entwicklungswege des Embryosackes der Angiospermen," (Diss. Stockholm).

16 Schnarf, K., *Embryologie der Angiospermen*, Berlin, 1929.

17 Modilewsky, J., *Ber. Deutsch. Bot. Gez.*, 1910, **28**, 413.

18 Lyon, F. M., *Bot. Gaz.*, 1898, **25**, 418.

Formation of a Quadrivalent Group in a Hybrid between *Triticum vulgare* and a *Tr. vulgare* extracted Derivative.

A *Tr. vulgare* type with $2n = 42$ chromosomes, extracted from a *vulgare-monococcum* hybrid (Kostoff, 1935)[1] was crossed with "normal" *Tr. vulgare*. During the first meiotic metaphase in the pollen-mother cells of the hybrid obtained, a quadrivalent group of chromosomes was very often observed. This phenomenon can be most probably interpreted by assuming exchange of parts (crossing-over) between two partially homologous chromosomes, obviously of B and C genoms in the F_1 hybrid *vulgare-monococcum* (Fig. 1—I, II, III and IV). In this hybrid as well as in *Tr. vulgare-Secale cereale* hybrid (Lebedeff, 1933),[2] autosyndesis was found obviously between the chromosomes of B and C genoms. The appearance of bivalent chromosomes in haploid *vulgare* (Gaines and Aase, 1926)[3] also indicates that autosyndesis may occasionally take place in *vulgare* when its genoms are in haploid condition. The derivative *vulgare*, that we crossed, seems to have one cross-over chromosome (C'), because no ring of four chromosomes was found but a chain with two somewhat larger and two somewhat smaller members. In all of the cells studied two of the chromosomes (1, 3) were directed to the one pole and the other two (2, 4) to the other pole. Only in one metaphase plate one chromosome was directed toward the one pole (2), while the other three were directed to the other pole (1, 3, 4). The interpretation is diagrammatically represented in Fig. 1.

Considering the above described phenomenon and the interpretations advanced, it can be inferred that the enormous number of forms produced in wheat species crosses and in crosses of wheat with allied genera is due not only to gene recombination between homologous chromosomes from the homologous genoms but also to the exchange of parts between partially homologous chromosomes from *vulgare* genoms autosyndetically (Duplication-deficiency). (Compare also Winge 1924;[4] and Kostoff, 1935[5].) Parallel with these the exchange of parts between non-homologous chromosomes (Belling, McClintock) as well as the increase mutation frequency following hybridisation (Belgovsky, Kostoff) should also be considered.

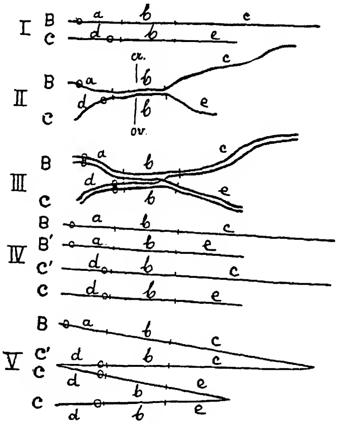


Fig. 1.

I, II, III and IV—in *vulgare-monococcum* hybrid. V—in the hybrid between the extracted derivative and "normal" *vulgare*. I—chromosomes B and C (one might be from genom B, the other from genom C) have a small homologous segment "*b*". II—leptotene, homologous segments attract each other, "*cr. ov.*"—the place where crossing-over takes place. III—diplotene (also autosyndetic bivalent with one chiasma). IV—second anaphase—two normal chromosomes (B and C) and two cross-over chromosomes (B' and C'). V—a quadrivalent consisting from three normal (B, C, C) and one cross-over chromosome (C').

DONTCHO KOSTOFF.

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[1] Kostoff, Dontcho, *Compt. Rend. Acad. Sci. USSR*, 1935, T.1, No. 2–3, 155.

[2] Lebedeff, V., "The phenomena of Autosindesis in intersp. hybrids of *vulgare* wheat", Kharkov, 1933.

[3] Gaines, E. F., and Aase, H. C., *Amer. Journ. Bot.*, 1926, **13**, 237.

[4] Winge, O., *Hereditas*, 1924, **5**, 241.

[5] Kostoff, Dontcho, *Sbornik Ceskosloven. Akadem. Zemedels.*, 1935, **10**, 389.

Perennation in *Cuscuta reflexa* Roxb.

OF all the Indian species of Dodders, *Cuscuta reflexa* appears to be hardier than others in attacking herbaceous as well as woody plants. No perennial *Cuscuta* has been reported from India, all the species being annuals like the European dodders.[1] One exception is *Cuscuta verrucosa*, which grows under the tropical sun and functions

throughout the year, wherever it has once attacked the host.[2]

Cuscuta reflexa parasitic on *Strobilanthus gossypinus* and *S. canaricus* over large areas in the sholas of Mysore forests has been observed to exhibit an interesting new method of perennation and growth. It grows rapidly during the rainy months of the year and after flowering gradually disappears. By the time the summer sets in, nothing is seen of the parasite till the next monsoon, when it makes its appearance again. Short period of rainless summer is passed by the parasite by two methods. First is the usual seed formation and the second is the perennation described below. At the beginning of summer, the parasite dies and disappears completely except some of its haustoria with their absorbing tissue, which remain embedded in the tissue of the host. The absorbing tissue becomes gradually isolated from the parasite on its death and decay, remains alive, though inactive, during the summer. Its requirements are well supplied by the host through the intimate connection of the xylem and phlœm of the host and the parasite.[3] Early in next rainy season, stimulated by the renewed activity of the host, these isolated absorbing tissues "Islands" embedded in the body of the host, organise several centres of growth, each of them will ultimately produce an young shoot or stem. Thus, number of young shoots are formed and they push themselves out of the cortex of the host. Further growth of these shoots results in the fresh attack of the uninfected parts of the host.

This method of perennation of *Cuscuta reflexa* appears to be an adaptation to the ecological conditions under which it is obliged to grow. *Cuscuta reflexa* cannot possibly continue its vegetative growth throughout the year like the above mentioned *Cuscuta verrucosa*, for reasons of marked variations in climatic conditions. Further difficulty is also felt by the parasite to propagate effectively, by means of seeds specially in the absence of proper hosts at proper stages of development in the immediate neighbourhood of the seedlings. It is essential to note in connection with the above that *Strobilanthus* occurs gregariously in vast numbers forming almost the sole undergrowth in forests which does not support another lower strata of vegetation, to serve as hosts for the seedlings of *Cuscuta*.[4]

L. NARAYANA RAO.

Department of Botany,
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March 23, 1937.

[1] J. D. Hooker, *Flora of British India*, **4.**

[2] Oliver and Kerner, *Natural History of Plants* (Eng. Ed.), **1,** 171–76.

[3] G. J. Peirce, *Ann. Bot.*, **7,** 291–318.

[4] J. C. Willis, *A Dictionary of Flowering Plants and Ferns*, 1925, 194–95.

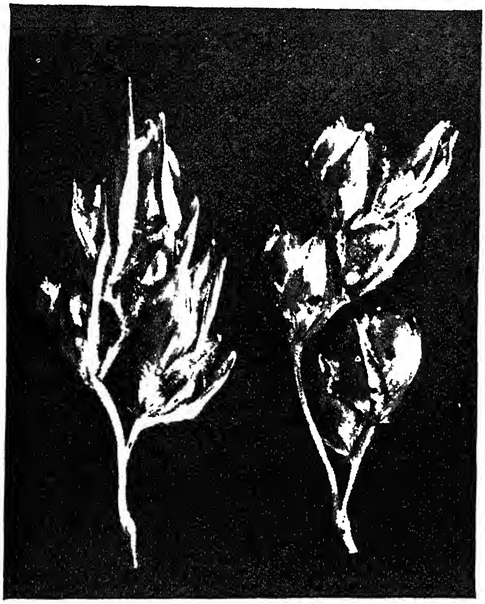
The Inheritance of Deciduousness of the Pedicelled Spikelets of Sorghum.

THE occurrence and inheritance of deciduousness in the grain bearing sessile spikelets of sorghum has been recently reported.[1] Pedicelled spikelets are a constant feature in sorghum earheads. They occur along with sessile spikelets singly and in two's at the terminals of the racemes. These pedicelled spikelets are usually abortive. The terminal ones may occasionally be antheriferous. The anthesis of these antheriferous flowers has been noted.[2] Pedicelled spikelets occasionally turn hermaphrodite.[3]

Pedicelled spikelets differ in their size, prominence and the length of their pedicels. In wild sorghums they are always deciduous. In cultivated sorghums they are usually persistent, though in some varieties they are deciduous (*vide* illustration). This character of deciduousness has proved to be of taxonomic value. As in the case of deciduous sessile spikelets, the pedicelled ones also, when deciduous, fall off breaking at the point of articulation of the spikelets with the tip of the pedicels, leaving conspicuous discoid white tips at the ends of the pedicels.

This significant character has proved heritable. *Sorghum margaritiferum*, Stapf. a variety of sorghum from Sierra Leone is characterised by deciduous pedicelled spikelets. In crosses between *Sorghum margaritiferum* Stapf. and the grain sorghum, *Peria*

manjal cholam (*Sorghum Durra*, Stapf.) var. *Coimbatoricum* (Burkill) Snowden (with persistent pedicelled spikelets), the first generation plants had persistent pedicelled spikelets.



Persistent Deciduous

Pedicelled Spikelets in Sorghum.

In the second generation there was a simple monogenic segregation between persistent and deciduous spikelets. The figures are as follows :

F_2 Family Nos.	Pedicelled spikelets	
	Persistent	Deciduous
A. S. 4746, 4747, 4772, 4773, 4973.	293	88
$X^2 = \cdot 7$	$P > \cdot 05$	

From this a third generation of 19 families was raised and of these 3 families bred true to deciduousness, 4 to persistence and 12 segregated again as follows :

F_3 Family Nos.	Pedicelled spikelets	
	Persistent	Deciduous
A. S. 4787, 4788, 4790, 4791, 4794, 4795, 4796, 4797, 4799, 4800, 4802, 4803.	438	136
$X^2 = \cdot 05$	$P > \cdot 05$	

A similar experience has been met with in another race of sorghum from Nigeria, *Sorghum caudatum*, Stapf. In family No. A.S. 4946 there was a segregation for this character, there being 67 earheads with persistent pedicelled spikelets and 22 with deciduous ones.

It will thus be noticed that the deciduous character has proved a simple recessive to persistence. The gene responsible for deciduousness of pedicelled spikelets has been designated sh_1. Sh_1 results in the persistence of pedicelled spikelets. Sh_1 is a simple dominant to sh_1.

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V. Panduranga Rao.
T. Venkataramana Reddy.

Agricultural Research Institute,
Coimbatore,
March 19, 1937.

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[1] *Curr. Sci.*, 4, (6), 299.
[2] *Ind. J. Agric. Sci.*, 1, (IV), 453.
[3] *Curr. Sci.*, 3, (9), 433.

REVIEWS.

Chemists, Lives and Works. By S. V. Divekar. (Standard Publishing Company, Bombay), 1936. Pp. xii + 298.

This book has been written ostensibly to help the candidates for the B.Sc. examination of the Bombay University. It gives the life and work of thirty-one famous chemists and covers a period of nearly a century and a half. The first chemist studied is Sir Henry Cavendish who flourished from 1731-1810. The youngest of the chemists studied is Henry Gwyn Jeffreys Moseley, the discoverer of atomic numbers, who met his premature end in his twenty-eighth year in 1915, while in active service in the Great War. The book includes also the lives of two living chemists—Richard Willstätter, familiarly known as the "Chlorophyll Wizard" and Sir Prafulla Chandra Ray, our distinguished countryman, who has been called the "Master of Nitrites" by Prof. Armstrong.

One chapter is devoted to each of the thirty-one chemists studied in the book. Each chapter begins with a portrait of the chemist. Then we have, on an average, a three-page chronicle of the chief events of his life. Then follow three more pages into which has been condensed a fairly exhaustive treatment of his chief contributions to Chemistry. The result is that we get a biographical picture of the eventful period commencing with 1784—when Cavendish published his studies of the properties of hydrogen and the composition of water in his paper entitled "Experiments on air" in the *Philosophical Transactions of the Royal Society*—and ending with 1929—when Jun Perkin laboured at synthesising dicentrine and narcotine.

A good deal of labour should have been spent in collecting the rich data scattered throughout the book. The educational value of the book would have been considerably enhanced if a short bibliography of sources had been added at the end of each life, with exact page references. A book written for B.Sc. students should aim not only at imparting information but also at leading the students on to the use of the original sources. It is the latter aim that is really more productive and valuable. No doubt, names of fifteen books and three journals occur under the heading "Bibliography" in a fly-leaf at the end of the book. But that is not the kind of bibliography that will stimulate the youth to further work. After all, the author should have had the exact references in his hands. Hence, it is desirable that they should be made available to the students, at least in the next edition, in the form I have mentioned.

S. R. RANGANATHAN.

Methods of Chemical Control for Cane Sugar Factories and Gur Refineries. Adopted by the Sugar Technologists' Association of India, Second Edition. (Published by the Sugar Technologists' Association of India, Nawabganj, Cawnpore, India), 1936. Pp. xiii+387. Price Rs. 10.

This book has been published by the Sugar Technologists' Association of India and is a compilation of all their approved methods of chemical control, according to a scheme drawn up by Noel Deerr. Unlike a mere compilation the book contains explanations of the principles and apparatus employed in sugar factory control.

It is divided into two parts. The first part is descriptive of the approved methods and the second part merely contains 32 useful tables and control-data sheets.

The book commences with a set of definitions approved by the Association and the Java Hawaiian definitions are included for comparison. The fundamental formulæ for factory control are derived in Chapter II and there the recommendation is made that "Sucrose" values should be made the basis of control in preference to "polarisation" figures. In the chapter on the control of the factory are included both the mill and boiling house control. The former is amply illustrated by typical Brix-variation curves.

The important and up-to-date methods for determining water, solids, fibre and sugar form the subject of two chapters and the principles, apparatus and procedure are fully explained with illustrations.

(*Continued on page* 551)

SUPPLEMENT TO

CURRENT SCIENCE

Vol. V | April 1937 | No. 10

The Problem of Reality in Physics.*

By Professor R. Ortvay, *Budapest.*

1. The Present Crisis in Science.

NOWADAYS we often hear the assertion that science is passing through a crisis. Popular works and newspapers speak of a "Bankruptcy" of science, and even some excellent representatives of science express the opinion that science is developing in a wrong direction. Others declare that the very aim of science, namely, the search for truth, is wrong, or, at least, fruitless; they only attribute a value to purposes of immediate utility. Others, again, fix their attention upon the radical change of the circumstances of life under the influence of technical sciences, and, regarding the numerous effects of industrialisation which have destroyed the equilibrium of social forces, often arrive at sceptical conclusions. And one of the strictest critics of our civilisation, the recently deceased Oswald Spengler, is, according to his great work *Decline of Western Civilization*, inclined to detect certain signs of decadence in some of the most glorious achievements of modern science.

While we cannot deny that there exists a crisis in our civilisation, manifesting itself in political and social restlessness, we also cannot doubt that in science, too, there is a certain crisis. This may give a justification for devoting a few words to the nature and importance of this crisis.

Many of you may be inclined to reject at once any doubt about the value of science. And I think, to the same group would belong everybody who has merely objectively witnessed the scientific development during the last decades, as well as the majority of those who take part in scientific movements. Science has passed from one triumph to another, succeeded in observing an immense multitude of facts and in explaining them from a unitary point of view; thus we are fully justified in calling the present time a golden age of science. And, if we consider the innumerable effects of science on practical life, the part steam and electricity play in it, or even the most recent inventions such as broadcasting, the applications of various radiations, aerial traffic, and so on, we likewise arrive at the conclusion that something causing such effects must certainly possess a deep-rooted intrinsic importance. For, even if we do not agree that the value

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* From a lecture delivered at the Indian Institute of Science, Bangalore, on 6th January 1937.

of science is given by its practical availability, we must acknowledge that practical effects are, though rather external, yet the more easily discernible signs of its importance.

On the other hand, science has undoubtedly undergone a very profound transformation in recent years. Many principles which were until recently regarded as incontestable axioms have lost this importance, and this can of course produce in a superficial eyewitness a feeling of uncertainty. Many excellent investigators who contributed fundamental discoveries to this transformation a few decades ago were unable to follow the further development and are now inclined to condemn it.

If, however, we examine the development of physics more attentively, we gain the conviction that the recent turn was entirely healthy and logical, without any sign of deviation or partiality, although the transformation of our ideas was very deep and we had to renounce many of them which formerly seemed evident. First of all we must emphasise that the whole development was continuous and smooth. Although it took a formidable pace during the last decades, we can say that the great discoveries followed one upon another continuously since the renaissance and particularly during the past century. We can even assert that the latest transformations, the atomic and electronic theory, the theory of relativity and the quantum theory, developed very smoothly, without deeper controversies, as if with a general consent. Struggles such as *e.g.* accompanying the Darwin theory of descent did not arise and it did not come, to the formation of great antagonistic schools. There was, of course, some contradiction, but partly of sheer outsiders and partly of physicists, who, although some of them had great merits as experimenters, were not sufficiently familiar with the language of mathematics which is so indispensable for expressing and understanding the physical contents of the new theories. All these controversies, although assuming sometimes, particularly in the case of the theory of relativity, rather grotesque forms, had only an insignificant influence on the development of science; among those possessing the necessary command of mathematics there was hardly any opposition and the foundations of the new theories now appear obvious facts in general opinion.

The theory of relativity presented itself immediately in a perfect shape, as the climax of a long evolution. The development of the quantum theory, however, was quite different. This fundamental theory of modern physics emerged as a very special hypothesis which could not be fitted into the frame of classical physics, and it grew after a long struggle to the present general theory. If leads to a modification of classical physics which is even greater than that effected by the theory of relativity, it demands a radical change in anciently-rooted ideas and presents a great number of unsolved problems. But, it has finally opened new domains and interpreted such important phenomena (I refer only to the theory of spectra and to the waves of matter), that its elimination from physics is impossible.

The continuity in the development of physics shows that the new great theories actually include the old ones; they acknowledge the validity of classical physics within the realms of observation it was meant to explain.

It follows that there is nothing in the development of physics to weaken our confidence in the healthy state of science. On the other hand, we notice that actually there is suech a distrust as a social phenomenon of to-day. Perhaps it is so because of the long continuance of the rapid development of science in a particular direction which, possibly, is not quite free from a certain onesidedness. Perhaps people are feeling that it is high time for other components of our civilisation to keep pace with the development of the exact sciences. Perhaps the effect produced by science upon the forms of life, the transformations in the production of goods, the modifications in the structure of human society are taking place too rapidly to ensue in harmony; this results in phenomena which certainly can be called critical. The problem of how to eliminate social and economic disharmony, however, cannot be solved by stopping the development of science; it must be solved, on the contrary, by the methods of science

themselves. Slogans such as "stop science" and similar demagogic anti-scientific catch words which we can hear nowadays in certain countries with a glorious scientific past, certainly can cause heavy damage to the development of science; such slogans are, however, not produced by the evolution itself of science but are mere symptoms of the general crisis of our civilisation.

Whilst we have thus to reject most decidedly any superficial and harmful assertion concerning the bankruptcy of science, we cannot deny that we have to face serious problems with regard to the effects of scientific development upon life as well as to its philosophical interpretation.

This lecture is intended to give the presentation of a problem of the scientific interpretation of the world. I hope to make a contribution to the solution of this problem which is the problem of *reality* in physics, the question what is to be regarded as *real* in natural sciences. Just in these days there is an ardent polemic on this matter between "positivists" and "realists"—a polemic which, of course, does not touch the existence and the foundations of science.

2. The Notion of Reality in Common Life and in Philosophy.

As long as we take a naive, uncritical standpoint with respect to the contents of our consciousness, the problem of reality does not present itself. In this stage everything occurring in consciousness appears as real; objects and sounds, dreams and fancies. The problem of reality first emerges when, in order to acquire a unitary scientific view of the world, we begin to distinguish between essential and unessential, between permanent and transient, between "real" and "apparent". These categories are correlative and appear always simultaneously. We shall consider a few examples taken from common life in order to fix the meaning we want to attribute to these words.

If my house burns down or a friend dies, these events will have portentous consequences upon my whole life; they will greatly influence the future contents of my consciousness. If, on the other hand, these events occur in my dreams only, they will have no such consequences; I shall dwell in my house as before and I shall continue to meet my friend. The two cases are quite differently related to other events of my life: the first is of serious consequence, the second remains an isolated event scarcely related to others. When we say that a political movement has a reality, whilst another lacks reality, then we understand that the former cannot be ignored without risking serious consequences, whilst the latter can be left out of consideration without incurring a risk.

When a solid body runs against me, it will hit me and possibly hurt me. On the contrary, a shadow running against me and falling on my body will have no serious consequences. When I plunge a rod into water, it will appear angular; after removing it out of the water, it is straight again. In other cases, when a rod appears angular, it cannot be used again and will soon fall into pieces. We cannot seize a *fata morgana* or a rainbow; these do not behave as real bodies.

These examples show how we discern in common life between real and apparent, or even between different degrees of reality. We see that it is the importance or the effectiveness which serves as a measure of reality, which is thus fixed by a judgment of valuation. It is often the mere persistence in time which forces us always to reckon with a certain thing and which consequently serves as a criterion of reality.

In philosophy the notion of reality has a similar meaning.

We remember the famous simile in Plato's dialogue on the "State"; here the perceptions are compared to shadows of bodies projected on a wall by a fire behind the spectator, bodies being in movement in front of the fire. The shadows represent the realm of the "apparent", the bodies moving in front of the fire those of the "real" beings; the simile has to explain that the objects as they appear to our senses belong to the realm of the apparent, whilst the eternal and unchanging "ideas" are representations of the sphere of the real. In Indian philosophy also, real and apparent are contrasted in a striking manner. Thus in Vedanta philosophy the world of *Maya* as the realm of the apparent, of illusion, contrasts with *Brahman*, the

unchanging, eternal, perfect, solely real being, the only existence which really deserves this expression.

In Buddhist scripture the things of the world are compared to "foam floating upon the Ganges" to "the *pisang* which lacks a solid framework", to a *fata morgana*, to a "bubble of water"; they are transient and unimportant. Contrasting with them there exists something defined by negative attributes only: the *Nirvana*, which, with all its negativity, plays exactly the same part as, in other systems, the highest degree of reality, the absolute reality or the Deity.

3. Realism and Nominalism.

In philosophy, a fundamental problem of any system is to determine what is to be regarded as real. Likewise, in the exact sciences the same problem is always present and passes through their history, as we shall see later. Here we shall mention two antagonistic points of view, the struggle of which runs through the entire history of philosophy and, in a modified form, can be found in physical discussions upon the question of reality. These antagonists are *realism* and *nominalism*. The idea of realism, that is, of philosophical realism, first emerged when people became conscious of the existence of abstract ideas, and recognized their importance. To-day we can hardly imagine how astonishing and admirable this perception must have been; the long-searched for Absolute Reality was thought to be found in abstract ideas. Thus, when Pythagoras began to have a present time of the actual importance of numbers, he thought them to be the true fundamental reality and made of them an object of almost religious worship. And Plato perceived Ideas as the really existent things, in contrast with the transient, alterable bodies given by sensuous perception; he founded a system of philosophy which, in a way is still existing.

The question concerning the nature and importance of ideas has since then always been on the programme of philosophy.

Opposing this realistic standpoint of Plato, there is another point of view, according to which there is no reality beyond the transient, alterable sensuous things; notions are mere names. Hence this standpoint is called "nominalism". These points of view are fighting one against another in the ideas upon the foundations of modern physics.

4. Positivism.

In the philosophy of to-day, nominalism appears in a characteristic form in the direction of epistemology which was started by the works of Ernst Mach, the Vienna physicist and philosopher, in the closest connection with the problem of the natural sciences and particularly of physics, and has become almost an official philosophy of the quantum theory of to-day. Phillip Frank is one of those who have worked out this program in detail. But also the great representatives of the quantum theory, Bohr, Heisenberg, Dirac and Schrödinger, share this way of thinking; Jordan has recently given a very clear and unexaggerated presentation of it in his newly published book. On the other hand, Planck, Laue and Sommerfeld are the chief representatives of the realistic point of view in physics.

According to Mach, our only direct data available are the sensations. Any other thing is composed of them; it is but a complex of sensations, either simultaneous or not. So are our notions, our logical functions such as judgment and so on. There is no physical reality independent of sensations; the postulate of such an independent reality is a mere logical construction which serves to express connections between our sensations, to foretell coming sensations. That my writing-desk is real, means only that some optical, haptical or thermal sensations by which its notion is defined always arise when circumstances are suitable, for example, when my eyes are opened, when a lamp is burning or when my hands are in a certain position. Beyond this nothing can be said and thus it is no problem at all but a meaningless question to ask whether the writing-desk exists when I am not observing it.

More generally, it has no sense at all to speak of the existence of a thing which cannot be observed; thus, *e.g.*, it is a senseless question whether other worlds exist

which are in no connection with our world. *Nothing exists that cannot be observed*: this is the view of positivism.

The recent positivism that has arisen from quantum mechanics is much less engaged in the analysis of sensations; it considers sensations rather as symbols which can completely be replaced by pointer-readings on instruments. They *should* even be replaced by pointer-readings for the sake of exactitude and unambiguity. This is obvious to the physicist; thus a certain colour can unequivocally be described from a physical point of view by a wave-length as the result of a diffraction experiment, unless we have to do with its bearing on physiology. According to this view the fundamental facts are pointer-readings or coincidences of a pointer and a point of the graduation; the problem is to find functional relations between different pointer-readings, to infer from certain pointer-readings other ones, occurring possibly in the future.

5. Analysis of Immediate Experience.

The common point of view, however, is quite different from this. Our attention is commonly directed to the things themselves instead of our sensations of them; in common life we neglect the accidentals adhering to our sensuous impressions. When we form an idea of a thing or a person, we do not imagine a certain perspective view of the object under a certain illumination, although our impressions always refer to such a particular picture; we think, on the contrary, of characteristic features that are common to all views of the object. The art of primitive nations deals, in the first place, with characteristic features of the object: the face is represented in profile, the eyes seen in front; it is a much later stage when a singular impression is brought into consciousness by a conscious spiritual effort. We try to pick out of the variable sensuous impressions a constant kernel on which, by preference, our attention is fixed; in common life we hardly care for the immediate pure sensuous impressions which only concern the psychologist in the moment he is at work. To fix the attention on the moon, or to be conscious of a yellowish circular optical impression, are quite different things; in the first case the yellowish circle is only a sign, a symbol of an object. This difference has, of course, nothing to do with the question whether I am, in an actual case, succumbing to an illusion or not. The elucidation of these things represents an important merit of the new psychology and phenomenology. In a similar manner, the properly so-called mental activities, judgments, and so on, cannot be derived from sensuous impressions and their succession; they are actually separated from them by a wide gap. If a physicist looks upon the sensuous impressions as the only ultimate elements, he accepts an entirely obsolete and incorrect psychology. Mach already has extended the circle of the immediately given elements by including the space-time structure of the world in it, and Jordan, in his above-mentioned excellent book, points out that certain "totality conditions", Ganzheitsbedingungen, must also be taken into consideration. Nevertheless, I think that positivistically-minded physicists do not recognise clearly enough how narrow and partial their picture of the immediately given elements of the world is. It would be very advantageous for them to learn to know some important psychological and phenomenological researches concerning the question of what is immediately given to us. The works of Husserl, Stumpf, Messer, Scheler are also accessible to physicists, though they may find some difficulties in the terms used by the philosophers. So far as I know H. Weyl is the only mathematician and physicist who is aware of these problems.

6. Physical Realism.

On the other hand, the state of mind of a physicist is much nearer to that of the common man than to the positivistic theory, as soon as he deals with a concrete physical problem, instead of the philosophy of physics. His interest is then directed, not to sensations or pointer-readings which play the rôle of mere tools, but to the objects themselves. In his paper entitled "Wege der Erkenntnis" Max Planck gives a very plastic expression to this point of view. Our theories refer to the moon, to liquids and solids, to atoms, molecules and electric fields, instead of direct sensual impressions. The fundamental task of physical research is just the construction

of a description of the world which is independent of our individuality and of limitations imposed by our organism. This, of course, can only be accomplished by a process of gradual development; we acquire step by step pictures of more and more profound reality. We can see this very clearly in the development of astronomy. The Ptolemaic cosmology attaches itself immediately to the observations of the curiously slung paths of planets as they appear to a terrestrial observer. On the other hand, the Copernican theory renounces a direct reference of the observed data to the terrestrial observer; it relates the planetary movements to the Sun and obtains thus very simple paths instead of the former complicated ones. By this simplification a path was opened to the establishment of fruitful hypotheses and the discovery of the laws of gravitation by Newton was made possible. Here the progress consisted of the choice of an invariant description instead of a description from the point of view of a particular observer. By this choice a mathematical description of the phenomena for any observer was rendered possible.

This process repeated itself much later in the theory of relativity and, in a more abstract form in the Dirac transformation theory of quantum mechanics.

The positivistic standpoint which endeavours to reduce everything to pointer-readings is, of course, not incorrect, as the facts can be described in this manner also; it is, nevertheless, extremely partial and even incorrect as soon as it pretends to be the only possible expression of the absolute truth. A comprehensive theory cannot be built up if nothing but the elements from which we start are permitted to figure in it. Otherwise our way of proceeding would be analogous to an effort to remove abstract ideas. Indeed, we teach children by telling them that two apples *plus* three apples equal five apples; two horses *plus* three horses equal five horses; but as soon as the child has conceived the idea of the abstract numbers, further learning on concrete examples is unnecessary.

7. Nominalism and Realism in Physics.

The antagonism between positivism and physical realism is analogous to the relation between nominalism and philosophical realism. According to nominalism and also to positivism, the only directly given data are the sensuous impressions; anything beyond them is a result of intellectual construction and is reducible to sensuous impressions. In opposition to this, realism attributes self-existent reality to notions and physical objects respectively. Here trivial contradictions result, of course if we do not discern sufficiently between physical objects and abstract notions. The notion of the number 3 does not float in the air between other things, nor exists in the time; but it has its " place " in the row of integers, *viz.*, between the numbers 2 and 4. We often hear that abstract notions can be constructed arbitrarily, whilst physical objects are given things with fixed attributes. We want to examine this question more closely. We can term a thing a Three, a Four or a Multiplication; by this, however, we only specify the notion we have in our mind, just as if we would state what physical object we intend to examine. After we have done so, we are no more free, *e.g.*, in prescribing what factors the number 6 may contain. The following arithmetical example may be useful with regard to the case of sensuous things and of physical objects also. An irrational number can be defined as the limit of certain sequences of rational numbers. Any proposition concerning irrational numbers can be interpreted as a proposition concerning such sequences; a representative positivistic philosopher, Ph. Franck, even says that an irrational number is nothing but a name and is identical with the sequence which serves to define it. This statement is true in so far as any proposition can be described by referring to the sequence only. It would, however, be partial and even false, if we would regard it as the only possible expression of the facts. We can, indeed, define an irrational number by means of an equation of which it is a solution; we can methodically deal with it on this basis as is done actually in the theory of algebraic numbers.

Quite similarly, we can express any relation between complex numbers as a relation between real numbers; we can regard a complex number simply as a system of real numbers. But we can also consider complex numbers as self-existent quantities defined by the rules they are obeying.

Correspondingly, we can regard a matrix equation in quantum mechanics as a symbolic expression of a finite or infinite number of ordinary equations. But this is one possibility only. We can also consider the matrices as defined by their operational rules and admitting an infinity of representations by means of ordinary numbers, none of which possesses a higher degree of reality than the others. In his profound book, fascinating in its ingenious exposition also, Dirac speaks of the notions of quantum, mechanics as follows:

"The new theories, if one looks apart from their mathematical setting, are built up from physical concepts which cannot be explained in terms of things previously known to the student, which cannot even be explained adequately in words at all. Like the fundamental concepts (*e.g.*, proximity, identity) which every one must learn on his arrival into the world, the newer concepts of physics can be mastered only by long familiarity with their properties and uses."

The fundamental quantities of quantum mechanics, the operators, are so far from our familiar notions that we cannot wonder at the acuteness with which the question of physical reality was reopened by the quantum mechanics.

8. The Relativity of the Logical Basis.

The above-mentioned examples from arithmetic (irrational and complex numbers, matrices) show that we can regard the same fact from many points of view, which are not at all in contradiction one to another. I think this fact leads to an adequate judgment of the relation between realism and nominalism, as well as between physical realism and positivism. In a logical system it is to a certain degree arbitrary what is to be considered as belonging to the basis of the system and what as a deduction. Thus we can build up geometry with many systems of axioms which we can choose differently among the propositions, just as we can represent a vector by means of different systems of fundamental vectors.

In my opinion, the same applies to the question concerning the mutual relation of nominalism and realism and the relation between direct sensuous experience and intellectually constructed physical reality. The characteristic feature of positivism is that according to it anything which is not directly observed possesses but a lower degree of importance. In connection with this, we must remark however, that the question of what is to be considered as immediate sensuous experience is not at all so simple and unambiguous as a naive psychology might suppose. We must bear in mind that things are arranged in a space-time order and that the nature of this order is an ancient problem of philosophy. In my view, the space-time order of the things is already the result of an elementary intellectual treatment of the raw material given by pure experience; we can call it a "natural" theory of the world. Positivism or nominalism and realism are two possible standpoints differing in the choice of the elements used for constructing a description of the world. They are both as well justified as the cosmologies of Ptolemy and Copernicus which differ only in the choice of the system of co-ordinates. We must be careful, however, not to believe that all similar philosophical and epistemological systems are true in every respect. We must, on the contrary, judge each case on its own merits, supposing that a conclusive judgment is possible at all at the present state of our knowledge.

9. Changes of the Notion of Physical Reality.

The history of physics offers numerous examples for the diversity of the ideas which at different times, served as fundaments for the description of the physical world.

Thus, in the infancy of physics, when it was not yet separated from philosophy, the central rôle was played by the doctrine of the four elements; fire, air, water and earth. To-day, in the possession of the idea of the chemical element, one is, in the first moment, inclined to smile at this naive conception. But looking more deeply into the matter, we see that the doctrine was quite adequate to the general level of those times. It contains, essentially, the most common representatives of the three states of matter and, besides, fire as the representative of temperature, the idea of which was not yet worked out clearly enough at that time. The view that all bodies result

from a suitable composition of those four elements is likewise not to be interpreted in the strict quantitative manner of modern chemistry; it means only that the state of all bodies can be expressed by means of those four "elements". The doctrine of the four elements appears thus as a primitive but by no means foolish attempt at systematising the reality. It only becomes absurd and senseless if looked upon from the present quantitative standpoint of science.

Another example is given by the cosmologies of Ptolemy and Copernicus which we have just discussed.

A particularly instructive example of changes in the idea of physical reality is offered by electromagnetism. In the classical theory of electricity and magnetism the fundamental laws refer to charges and poles, the forces acting between them being given by the well-known Coulomb laws. In this system electric and magnetic fields are of secondary importance. Energy and potential appear as important auxiliary notions which serve for expressing properties of systems of charges; their physical reality, however, is of a lower degree than that of the charges; they possess no substantiality.

The electromagnetic field and the energy appear, then, as fundamental notions and even as substances in Maxwell's electrodynamics. Here the field is not a mere auxiliary construction, determined by the distribution and motion of the charges in a certain moment; with Maxwell, the field is a self-existing entity and the charges are, in a certain sense, degraded to mere singularities of the field, to places where the lines of force join one another, the divergence being there different from zero. Energy, on the other hand, is localised and possesses a mass. Thus the view expressed first, though in a somewhat vague manner, by W. Ostwald, according to which energy is to be considered as the fundamental substance, was realized in a concrete form in electrodynamics and in Einstein's theory of relativity, representing a foundation-stone of our present conception of physics. (We can, of course, interpret the equations of Maxwell by referring them directly to electrical charges; this would, however, be rather forced.)

A more recent example is given by the quantum theory of the electromagnetic field. It was known for long that a given electromagnetic field can be developed into a Fourier series. But it was the quantum mechanics which attributed a self-existent importance to the individual terms of this Fourier series, considering them as a sort of co-ordinates and submitting them to the procedure of quantization. This idea of Dirac has then been applied to the case of waves of matter (Jordan and Wigner).

The criterian of reality suffered a thorough alteration in quantum mechanics and this process has, perhaps, not yetc ome to an end. With regard to this matter, I shall limit myself to a few hints. In the first place it turned out that the fundamental notions of classical mechanics such as the momentum, energy, etc., are to be replaced by certain operators which lead to the possible values of the corresponding quantities as they can be measured by observations. The mutual relations of the dynamical variables are also to be replaced by relations between the corresponding operators. These new relations, however, are generally not identical with the corresponding classical relations. The notion of the state of a system has also undergone incisive alterations as compared with the classical way of thinking. It turned out that in contrast to classical mechanics, we cannot attribute numerically determined values to all variables of a system simultaneously. Thus, *e.g.*, we cannot determine simultaneously both the position and the velocity of an electron. Since we can, according to the positivistic view, only speak of quantities which can actually be measured, we must say that in a given state of a system certain mechanical variables (*e.g.*, the position of an electron, the velocity of which has previously been determined exactly) actually have no sharply defined values at all. If we make a measurement which leads to a defined value of such a quantity, then we must admit that after the measurement the system is no more in the state which existed before the measurement, since in this state the measured quantity had no value at all.

If, however, the measurement refers to a quantity which has been measured immediately before, then the repetition must lead to exactly the same value. By this fact, I think, we are entitled to attribute to a state the same objective existence

as in the classical theory; the change would only refer to the manner in which the state is defined. We often hear the opinion that we cannot attribute objective characteristics to a system, since the data describing it depend on the results of measurements. This view, however, is not correct. We need a certain measurement in order to bring the system into a defined state; after this is done, any further measurement which refers to the same quantity and thus does not alter the state of the system, leads to the same result.

We can also describe a state in the following manner. A certain measurement may have previously been performed which leaves the system in a state in which a certain quantity other than the measured one (the so-called "conjugate" quantity) has no defined value at all. Then the state is completely described if we know the probability of any possible result of a measurement of this second quantity. These probabilities are given by the solutions of the Schrödinger equation. The ψ of Schrödinger, the wave function, describes the state of a system by relating it to a given ground state. For example, if the state of a hydrogen atom is given by fixed values of the energy, of the absolute value of the angular momentum and of a component of the latter, then $|\psi|^2 dV$ gives the probability of finding the electron in a space element dV. This we must understand in the following manner. The measurement of the position of the electron is, in the sense explained above, incompatible with an exact measurement of the energy or momentum. In consequence of this, we destroy the state with a fixed energy and angular momentum by measuring the position, we then obtain a new state with a determined position but undetermined energy and momentum. The probability of obtaining a given position by measuring it in a system with given energy and momentum is then determined by Schrödinger's equation.

10. Summary.—The Value of Positivism.

The essential contents of our exposition may be summarised by saying that positivism and realism, and nominalism and realism respectively are both admissible points of view if they are carried through correctly; they only differ in their starting-points. Positivism, in the form which was developed under the influence of quantum mechanics, leads to a profound change of our idea of the physical state of a system. In my opinion, however, it does not destroy the notion of the objectivity of a state; it merely claims that, for defining a state, certain necessary measurements must have been performed. By this demand the objective existence of a state is not affected, just as the objectivity of space is not affected by the fact that when I say that a star is at the zenith, I must add the geographical position and the time the zenith is referred to.

On the other hand, I must object to the psychological doctrines concerning immediate experience as they are used in the physical literature of to-day. Similarly, I cannot agree with certain exaggerated positivistic statements, as for example with the identification of observability and existence.

In connection with this, I may return briefly to a frequently heard example of a statement which is meaningless in the positivistic sense, namely, to the possible hypothesis that a world may exist which has no connection with our world. Such a hypothesis could, of course, not be tested by observation. But we can imagine the case that the masses in the world gradually accumulate at two different places and thus the world divides into two separate parts. After this process is completed, two worlds exist which are possibly without any connection.

There is an analogy between this example and the problem of the psychological accessibility of strange persons. The feelings or impressions of other people are entirely inaccessible to a direct observation; for example, I do not know whether the impression my friend has at seeing a certain colour is the same as my own impression or not. Here we can help ourselves with analogies only. And now I think we are on the wrong path if we infer that the existence of my friend consists merely of my having certain sensuous impressions of him.

Finally, there are parts of the world which I never can observe and yet I must suppose them as existing. I speak of the

state of the world after my death. I can feel deeply concerned at the development of politics or of science after my death, although these things cannot be observed by me.

In the book which we have mentioned already, Jordan claims that it is the life of the human race instead of the individual life to which all similar problems must be related. In this case, however, we must decide to acknowledge an existence which transcends the circle of our own experience, namely, the existence of other persons which is more than a mere part of our own individual experience. I think that in doing so the dogmatic positivism falls to pieces. There survives, however, in any case the important work performed by positivism in eliminating many meaningless questions, and there survives the profound modification by the quantum mechanics of our idea of the physical state.

I think that the idea of physical reality needs a long development to appear at last in complete clarity and that this development has been strongly advanced by positivism. On the other hand, quantum mechanics most probably cannot be considered as the final stage of this development. Quantum electrodynamics and the problem of the elementary corpuscles even point at profound gaps which are yet to be filled.

Man is inclined to consider the stage he has just arrived at as the revelation of the absolute final truth; this illusion is almost a matter of course. It is good therefore to remember Newton's words:

"I do not know what I may appear to the world, to myself I seem to have been only like a boy playing on the seashore, and diverting myself in now and then finding a smoother pebble or a prettier shell than ordinary, whilst the great ocean of truth lay all undiscovered before me."*

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* D. Brewster, *Life of Newton*, p. 338.

For determination of reducing sugars the Association recommends the Munson-Walker and Eynon-Lane methods. Sulphate ash without the 10 per cent. correction is preferred to the carbonate ash and the conductivity method is described.

The subjects of pH control and polarimeter are dealt with in two chapters which are specially well written. A description of fuel control and recording instruments and the colour comparison of sugars are given in two chapters which are indeed very useful additions. The control of Gur Refinery is rather meagerly treated and is disposed off in less than two pages.

This publication is claimed to be the second edition of a work published in 1928 but it cannot be denied that this has entirely superseded its forerunner, in subject-matter and scope. The book has been wholly recast and is made to include references to standard publications. It is not intended to be a treatise on "chemical control" and therefore does not contain a discussion of the numerous methods in literature but the recommended methods are quite up-to-date and have been introduced with a full knowledge of similar methods adopted in other leading sugar countries and also the recommendations of the International Committee.

The publication of this book, at a time when standardisation and uniformity in the control of Indian factories are badly lacking is quite opportune and there is no doubt that our factories will increasingly adopt the methods recommended in it. The scope and treatment of the subject-matter are by no means restricted to Indian conditions. While the book becomes a necessary adjunct of every Indian Sugar Laboratory it will certainly be a very useful reference work abroad.

G. G. Rao.

Commercial A.C. Measurements. By G. W. Stubbings. (Chapman and Hall, Ltd., London), 1937. Second Edition Revised. Pp. 348, 169 illustrations. Price 15*sh.* net.

This book of ten chapters and an appendix, deals with the theory and practice of the measurement of current voltage, power, energy and power-factor in A.C. currents and is of great value to testing Engineers of all grades in the factory and on inspection work. The major part of each chapter consists of the presentation of experiments together with the discussion of the associated theory and phenomena.

The first two chapters explain the fundamental theory of alternating current and measurements, three phase systems, harmonic analysis and are illustrated with general equations and typical vector diagrams for connections of various types of instruments.

In the next two chapters, the methods of measurement of current, voltage and power are discussed with illustrations explaining the construction and use of various types of apparatus including the A.C. Potentiometer. The chapter on power and its measurement is comprehensive in dealing with the various standard methods and the apparatus used for the purpose.

The next chapter explains the theory of instrument transformers and their test and application. The following four chapters concern the measurement of energy, power-factor and re-active volt amperes and the use of various types of instruments and apparatus illustrated with diagrams. The last chapter is devoted to test room apparatus and the general design and equipment of a Testing Laboratory. The latest types of apparatus including the oscillograph and the harmonic analyser are thoroughly discussed.

The useful references to other published literature at the end of every chapter facilitates collateral reading and the treatise is to be classed as one of the standard books on Electrical Technology.

R. P.

Mathematical Snack Bar. By Norman Alliston. (Published by W. Heffer and Sons Ltd., Cambridge), 1937. Pp. 155. Price 7*sh.* 6*d.*

The volume may well be described as a collection of mathematical tit-bits, comprising certain Pythagorean, Diophantine and allied problems. The few rather apologetical remarks made by the author in his preface leave little room for any further or lengthy comment. To the great delight of the reader many problems in this "Snack Bar" smack of old acquaintances; he finds here solutions of many problems, which had once baffled him or which he had already solved in a similar if not the same way. The happy language which runs through the pages unfolding mathematical truths and surprises (such as "a straight line is the longest distance between two

points "), is not without its own surprises of word combinations. Mention must also be made of the choice of names like "gravity point" for "centre of gravity", "ad-circle" for "ex-circle". The book stimulates an amateur to mathematical pursuits; even the specialist would find it interesting reading. It may usefully be acquired by libraries of junior colleges. B. S. S.

Analyse des Matieres Crystallisees au Moyen des Rayons X. By M. E. Nahamias. (Actualites Scientifiques et Industrielles, Hermann and Cie., Paris.) Pp. 332. Price 15 *francs*.

In recent years X-ray diffraction methods have been employed for purposes of identification and analysis of crystalline materials. The potentialities of the X-ray method for these purposes are very well brought out in the above monograph, the author of which has himself made many valuable contributions to the subject. A very clear description of the various methods of work are given in lucid style and it is hoped that the monograph will be welcomed both by mineralogists and analytical chemists. In Chapter II methods are set forth in full detail for quantitative determination of the crystalline constituents of a mixture. The monograph is well illustrated by X-ray powder photographs of various minerals.

S. R. S.

'Saltation in Fungi.' By Dr. S. N. Das Gupta. (Lucknow University Studies, No. 5. Edited by Prof. B. Sahni, SC.D., F.R.S.).

This little volume forms the fifth publication of Lucknow University Studies, and is based on a course of three lectures on Saltation and Related Phenomena in Fungi delivered by Dr. Das Gupta at the Lucknow University during the session 1934-35.

Though a large amount of work has been done in this field, Dr. Das Gupta rightly points out that our knowledge regarding saltation is meagre and that the facts that are before us do not allow of any generalisation. The term 'saltation' (sometimes also called mutation or sport) is used when a new strain is formed from an apparently pure strain of fungus, and it indicates that in some hyphæ of the parent mycelium the genetic constitution of one or more cells had undergone a definite change due to either morphological or physiological factor or both. The papers on different types of saltations and induced saltations and the difference between the parent and saltants regarding the morphological, physiological and parasitic activity have been discussed and presented in a very readable form. In the last chapter of this little volume references have been made to bud-variation and plant-chimæras in higher plants which are comparable to saltation in fungi and the production of 'Mixochimæras' in *Phycomyces nitens* and in *Botrytis* has been referred to.

Dr. Das Gupta has given us a concise account of the available facts relating to various aspects of saltation up to 1934 and his references to over 150 original papers on this subject will be very useful to the workers in the field. H. C.

An Outline of Indian Temple Architecture. By F. H. Gravely, D.SC., F.A.S.B., Superintendent, Madras Government Museum, Madras. (Government Press, Madras.) Price As. 12.

The Madras Government Museum has been long famous for its *Bulletin*, first issued by the late Dr. E. Thurston, who was known for his versatility. The new series now being published under the Editorship of Dr. Gravely, maintain the high level of scholarship, which marked the earlier numbers and are accordingly to be welcomed in circles interested in humanistic studies. The present number forms Part II of Volume III of the General Section of the New Series and is devoted to a topic that is bound to appeal to a large class of students. Temple architecture has been a subject of great interest from early days in India. Fergusson, who made the modern world know of the rich architectural and sculptural treasures of this country, was a poineer in this line of study. His writings possess a unique value even to-day and his descriptions, brief, succinct and apposite, are characterised by a charm and subtlety that defy definition. His theories invited adverse criticism even in his own days, notably from Ram Raz, the first Chief Justice of the Mysore Huzur Adalat Court, when it was constituted in 1832. Fergusson wrote at a time when Oriental studies had not yet been developed on any large scale and he was, besides, ignorant of Sanskrit and of the works bearing on Hindu architecture. But he was a genius and did much to popularise the scientific study of Indian

Antiquities, for which the people of this country will be ever beholden to him.

Few will quarrel with Dr. Gravely when he suggests that the division of Indian Architecture into Buddhist, Jain and Hindu is not strictly correct as all their beginnings can be traced to the original Hindu style. But when he seeks to make out that Fergusson's "separation" was meant to meet anything more than a mere differentiation for purposes of practical study, he seems to be unconsciously doing injustice to that great authority on architecture. Fergusson knew too much of Indian Architecture to be guilty of such an obvious mistake. It has been truly said of him that he invested the historical study of Architecture, particularly Indian Architecture, with a new interest. Nor is Dr. Gravely on a safe ground when he throws out the hint that temples may be classified under the heads of "Tamil", "Kanarese", etc., on the basis of what may be called "linguistic" and "territorial" areas, as these areas have changed from time to time owing to historical causes. Nor are differentiating phrases like the "Northern form" and the "Southern form" any more happy. The complexities of the problem discussed by Dr. Gravely are only increased by the use of phrases and terms of this kind and the classification of ideas he so much desires is not likely to be attained by their use in this connection. The fundamental point to grasp is that we should first know the theory as such of temple construction and from it proceed to the study of the actual examples available to us in the country and build up our history of temple architecture from it. Such a study as this is not only laborious, but also envisages qualifications in research students which may not be found available in one and all who seek to approach this subject. But that only shows how our equipment has to be improved and made suitable for the objective aimed at. Otherwise, we are bound to meet with phrases like "Temple of southern form, Tamilian style", etc., which suggest ideas which cannot but be characterised as having a half linguistic and half territorial basis. The attempt to study temple architecture and temples without any idea of the theoretic basis on which they have been built is doomed to failure. You can study temples, as Fergusson indeed did, from an *a priori* point of view and with the aid of traditional history fix up, as he did, their age. With the knowledge thus derived, classify the styles, as he did, from a territorial and a semi-historical standpoint. The other way to study them would be to learn the underlying original theory, and try to see how the actual examples left to us have proceeded in the hands of builders, noting the divergences as you go on. The influences—foreign and other—would thus be traced to their native sources and the data arrived at would enable one to draw up a classification on what might be termed a scientific basis. Any other method would not prove satisfactory for the simple reason that it would lack the foundations for a sure study of the subject. Is the term "Dravidian" Ethnic, territorial or linguistic in its significance? Dr. Gravely himself complains that Dr. Jouveau-Dubreuil has, in *Archéologie du Sud l' Inde* has restricted the "meaning of the term Dravidian". What we say is that he cannot but so complain in the circumstances we have detailed above. His suggestion that we should use the word—"Dravida" in connection with architecture and not "Dravidian" is no improvement, in our opinion, as it equally connotes both a linguistic and territorial idea, if not also an Ethnic one. The difficulty is inherent in studies of this kind which do not proceed from connected knowledge of the theoretic basis on which they actually stand. The whole of Dr. Gravely's paper is enough evidence, if evidence were needed, of this prime difficulty. His conclusion after a study of different styles—whether there is not fundamental unity underlying all the various styles of Indian temple architecture—is itself fully confirmatory of the soundness of this remark.

Dr. Gravely deserves to be warmly congratulated on the production of a monograph which has served to draw pointed attention to a subject which still awaits the study of competent scholars in this country, a study which is as necessary as it is difficult.

The monograph, we may add, is well illustrated and is bound to create interest in the subject to which it is devoted. It suggests the need for an architectural survey of India on lines more intelligible and scientific than we have had so far and if it did nothing more, it would have served its purpose.

C. Hayavadana Rao.

Fish and Mosquito Control.

IN a recent article Dr. B. Prashad and the writer gave a general review of the probable larvivorous fishes of India. In this article the Indian literature on the subject was reviewed and the classification of the probable larvivorous fishes of India was dealt with in a general way. Attention was also directed to the importance of biological control and suggestions were made for future work. One of our suggestions was that "Observations should also be made regarding the natural food of the various types of fishes by an examination of their stomach contents." Fortunately workers interested in the control of mosquitoes had already realised the importance of the above subject and, instead of studying the feeding habits of fishes in aquaria under laboratory conditions, had gone into the field to elucidate the natural food of the species to be utilised in anti-malaria measures. Two such recent attempts have come to the notice of the writer. Dr. Sen has studied the "Food Factors of the So-called Mosquito-Destroying Fishes of Bengal—*Panchax panchax*, *Barbus stigma*, *Esomus danricus* and *Trichogaster fasciatus*", and the data, which he presents, show that under natural conditions these fishes do not feed on mosquito larvæ; in the case of *Panchax panchax*, however, he noticed that "*Anopheles* larvæ were detected in the gut of only about ten per cent. of the total fish examined." Professors N. P. Sokolov and M. A. Chvaliova, on the other hand, in their observations on the "Nutrition of *Gambusia affinis* on the rice fields of Turkestan" remark that

"1. *Anopheles* play an important role in the food of adult *Gambusia* on the rice fields, amounting to 32·8%; Ephemeridæ, 21·9%; Rynchota, 21·5.

"2. *Anopheles* larvæ form the bulk of the food of the young fish, amounting to 64·8%.

"3. *Gambusia affinis* exterminates the *Anopheles* larvæ to about 80-90%. This shows the important role *Gambusia* plays in the ecological method for combating *Anopheles* larvæ on the rice fields."

The results of Dr. Sen and Professors Sokolov and Chvaliova are so widely different that a layman may well feel bewildered in deciding whether fishes could play any part whatsoever in the eradication of mosquitoes. A careful study of Dr. Sen's work, however, leads one to the conclusion that his technique, as detailed below, must have been mainly responsible for the results which differ so materially from those of the Russian workers. The technique employed by him was to remove the "mid-gut"* on a slide and its contents "were then squeezed out from one end on the slide and examined under the microscope". Though the next section is entitled "Analysis of Stomach Contents", in the text reference is only made to "gut" and it is difficult to make out as to which part of the alimentary canal the author refers; it is certainly doubtful whether he uses it as a synonym of stomach in fishes. In the case of fishes the contents of the stomach, which is situated between a short œsophagus and a long or short intestine, have to be studied to determine their natural food. Dr. Sen did not preserve his fishes as they were caught, but usually allowed 2 to 3 hours or longer to lapse before placing them in the preservative. It is no wonder, therefore, that Dr. Sen found the food materials in the "gut" of the fish "in an advance state of digestion".

Professors Sokolov and Chvaliova, on the other hand, record that "The analysis of *Gambusia* food was done by the usual method in ichthyology of examining the stomach contents." They found, however, that even this method proved insufficient to show the entire process of nutrition in fishes, and accordingly carried out some ingenious physiological experiments to elucidate the problem of *Gambusia* nutrition. They found that at a temperature of 30° C. "the process of digestion begins about 2 hours after the larvæ are swallowed. A complete discharge of the stomach takes place in 3-4 hours, except for the chitinous parts which remain in it longer." Low temperatures, however, cause a slowing-down of digestion. They further found that the intensity of digestion remained the same whether the fish were fed on *Daphnia* or on *Anopheles* larvæ. Further they investigated the rate at which *Gambusia* swallows larvæ and found a close correlation between it and the rate of digestion. Though they failed to achieve complete extermination of

* Dr. P. Sen informs me that by "mid-gut" he meant stomach.

Anopheles larvæ even at a density of 2·3 Gambusæ per sq. mile, they found on the rice fields that the average extermination extended to 93·1 per cent. From their experiments and observations Sokolov and Chvaliova conclude that "*Gambusia* may be regarded as a sufficient agent of repression with the *Anopheles* larvæ, without applying any other methods."

The writer has for long been of the opinion that biological control of mosquito larvæ by the use of fish will prove very effective in India, but considerable work on *proper lines* remains to be done to determine the utility of the different species under field conditions; and in this connection the methods adopted by Professors Sokolov and Chvaliova should prove very helpful.

S. L. HORA.

Prashad, B., and Hora, S. L., "A General Review of the Probable Larvivorous Fishes of India," *Rec. Malaria Surv. Ind.*, 1936, **6**, 631–648.

Sen, P., "On the Food Factors of the So-called Mosquito Destroying Fishes of Bengal—*Panchax panchax*, *Barbus stigma*, *Esomus danricus* and *Trichogaster fasciatus*," *Curr. Sci.*, 1937, **5**, 357–361.

Sokolov, N. P., and Chvaliova, M. A., "Nutrition of *Gambusia affinis* on the Rice Fields of Turkestan," *Journ. Animal. Ecol.*, 1936, **5**, 390–395.

ASTRONOMICAL NOTES.

1. **Comets.**—The first Comet of the year was observed by Mr. Simizu in Japan. The object has been identified as Daniel's Comet 1909 IV which has not been seen since discovery in 1909. The computed period is about 6·8 years.

Comet 1937*b* was discovered on February 7, by Dr. Whipple of the Harvard Observatory. The estimated magnitude at the time was 12 and it had a short tail several minutes of arc in length. From the ephemeris based on the orbit calculated by Dr. Whipple, it is noted that the Comet will be in favourable position for observation during the next two months.

2. **Transit of Mercury.**—On May 11 the planet Mercury will be in inferior conjunction with the Sun and will partially transit over the Sun's disc. The phenomenon will be generally visible in Southern Asia and the central and southern parts of Africa. At Madras the ingress will occur at $2^h\ 14^m$ P.M. and egress at $2^h\ 46^m$ P.M. Indian Standard Time, and at Bombay the times are $2^h\ 18^m$ and $2^h\ 42^m$ P.M. respectively. The maximum ingress will be $7''\cdot3$, the true diameter of the planet being $12''\cdot02$.

3. **Planets in May 1937.**—The planet Venus will be a morning star throughout the month and will attain greatest brilliancy on May 24. Mars is a bright object rising in the early part of the night; it will be in opposition to the Sun on May 20 and will approach nearest the earth on May 28. The planet will be found a little to the west of the bright star Antares (α Scorpii). The two objects, being nearly of the same colour, present a noteworthy appearance in the evening sky. Jupiter rises about midnight and will be almost overhead early in the morning before sunrise. Saturn will also be a morning star, rising about two and a half hours after midnight in the middle of the month. The rings are gradually widening and can be seen with telescopes of moderate size.

4. **The System of Capella.**—The star α Aurigæ (Capella) was found by Campbell to be a spectroscopic binary with a period of 104·022 days. Later measures at Mount Wilson with an interferometer have confirmed the period. The star has a faint companion (magnitude 10·6) about 12′ distant, having the same proper motion. In *Astronomical Journal*, 1048, C. L. Stearus remarks that on photographs obtained by him, the image of this companion shows a distinct elongation and suspects, that it is also a double star. Kuiper, observing with the 40″ Yerkes' refractor, has confirmed (*Ap. J.*, Oct. 1936) the star being a close double, so that Capella appears to be a quadruple system of the ϵ Lyræ type.

5. **New Stars.**—The four Novæ which were observable about the end of 1936 are still fairly bright and can be seen even with small telescopes. Nova Herculis—the star that had its outburst in Dec. 1934—appears to be steady at the eighth magnitude with only some small fluctuations in brightness. The two Novæ in Aquilæ are slowly declining, the magnitudes of both on March 11 were estimated to be 9·7.

CENTENARIES

S. R. Ranganathan, M.A., L.T., F.L.A.
University Librarian, Madras

Parmentier, Antoine Augustin (1737-1813)

PARMENTIER, a pharmaceutist and writer on agriculture, was born at Montdidier on April 17, 1737. His early education had to be received solely at home and was rather incomplete. Later, he studied pharmacy in the shop of a local apothecary. Having held a commission in a military hospital in 1757, he again prosecuted his study of chemistry at Frankfort-on-the-Maine and later, in 1763, in Paris. In 1766, he obtained by competition, the situation of Assistant Apothecary in the Hotel des Invalides; and in 1772 he became the Apothecary-in-chief.

His Writings

He wrote about twenty-five books. His first book *Examen chimique de la promme de terre* was published in Paris in 1773. The last book which came out in 1812 was on *Formulaire pharmaceutique a l'usage des hopitaux militaires*. The most considerable of his books was the *Economie rurale et domestique* (1790) which was in eight volumes. He began to write to periodicals rather late in life. His first paper appeared only in 1791. It came out in V. II of the *Annal. de chemie* under the title *Sur la nature et la maniere d'agir des engrais*. But once the ice was broken, he began to contribute regularly to learned periodicals. Forty-seven papers of his came out in the twenty-two years of his life that remained. He wrote his last paper just before his death and it appeared in V. 41 of the *Gilbert annal.*

His Contributions

His first contribution of note was his essay on alimentary substances which might be used in times of famine. This essay won for him the prize offered by the Academy of Basancon. He also called attention to the starchy matter in plants and especially to the cultivation of the potato. He devoted much thought to the improvement of the diet of soldiers and to the use and preparation of grape sugar. He examined the food value of several materials and wrote a treatise *On the best method of making bread.*

He died at Paris on December 17, 1813.

Bennett, Edward Hallaran (1837-1907)

E. H. BENNETT, Irish surgeon, was born at Cork on April 9, 1837. His father was recorder of Cork. His maternal grandfather was an M.D. and made some reputation as a writer on insanity. His paternal grandfather was a physician at Cork. Bennet had his education at Hamblin's School at Cork, at the Academical Institute, Dublin, and at the Trinity College, Dublin. In 1859 he graduated M.B. and M.Ch. In 1863 he became a Fellow of the Royal College of Surgeons in Ireland. In 1864 he became an M.D. and got the position of University Anatomist and of the Surgeon to Sir Patrick Dun's Hospital, Dublin. These posts he held till 1906.

His Special Field

Bennet was an authority on fractures of bones. His name has been immortalised in the term *Bennett's fracture*, which is applied to a form of fracture of the base of the metacarpal bone of the thumb. As it closely simulates dislocation, it was not recognised till 1881, when Bennett gave an account of it before the Dublin Pathological Society. As an operating surgeon, he was one of the first surgeons of Ireland to apply Listerian methods. He wrote about eight papers, the first entitled *Fractures of the costal cartileges* having come out in 1876 in V. 61 of the *Dublin journal of medical science.*

His Honours

He was a popular and effective teacher. He had the reputation of enlightening the driest subject with touches of humour. In 1880, he was elected President of the Pathological Society of Dublin. From 1884 to 1886, he was President of the Royal College of Surgeons of Ireland. From 1894 to 1897 he was President of the Royal Academy of Medicine of Ireland. From 1897 to 1906 he represented the University of Dublin on the General Medical Council. He was elected an Honorary Fellow of the Royal College of Surgeons of England. A Bronze Medal has been founded to be awarded biennially to the winner of the surgical travelling prize. It bears on one side a portrait of Bennett and on the other a metacarpal bone showing *Bennett's fracture.*

Bennett died at Dublin on June 21, 1907.

McLachlan, Robert (1837-1904)

ROBERT McLACHLAN, British Entomologist, was born in London on April 10, 1837. He was the son of a ship's-chandler, who left him some considerable property. As a boy he took great interest in Botany. When eighteen years old, he made a voyage to Australia and China, where he collected much botanical material, which was subsequently examined by the Keeper of the Botanical Department of the British Museum. About this time, however, a change came over his field of interest. This change was brought about largely by the prolific writings of Hermann August Hagen, the German entomologist, who settled in the United States and became the father of the American school of entomologists. Hagen's articles in the *Entomologist's annuals* drove Robert's interests to Neuroptera.

His Contributions

Robert McLachlan was a prolific writer. As many as 228 papers of his were published in various periodicals. His first paper appeared in 1861, in the first volume of the *Transactions* of the Entomological Society. It was entitled *Descriptions of the British species of the genus stenophylax*. His *Catalogue of the British neuroptera* was published by the Entomological Society in 1870. His chief independent work is said to be *A monographic revision and synopsis of the trichoptera (caddis-flies) of the European fauna.* This great work was illustrated by his own detailed drawings and came out during the decade 1874-84. He also wrote the article on *Insects* for the ninth edition of the *Encyclopædia Britannica*. He was mostly interested in the anatomy of insects.

His Collections

McLachlan was an enthusiastic collector. He was in constant touch with the leading neuropticists of the world, and he was able to bring together one of the finest collections of neuroptera in the world.

His Honours

McLachlan was a member of many British and foreign learned bodies. He was elected a Fellow of the Linnean Society in 1862 and of the Royal Society of London in 1877. He was the President of the Entomological Society in 1885–1886. He was entrusted with the editing of the *Entomological monthly magazine*, which he founded with others in 1864.

McLachlan died at Lewisham on May 23, 1904.

Scudder, Samuel Hubbard (1837–1911)

S. H. SCUDDER, the greatest American orthopterist of his time, was born in Boston on April 13, 1837. His interest in entomology was aroused during his first year of college by a case of butterflies in the room of a friend. He had a chequered career, having been as Assistant in the Laurence Scientific School from 1862 to 1864, Keeper of the Boston Society of Natural History from 1864 to 1870, without employment from 1870 to 1879, Assistant Librarian of the Harvard University from 1879 to 1882 and finally a Palæontologist in the United States Geological Survey from 1882 to 1892. With his library career is associated his *Catalogue of scientific serials of all countries... 1633—1876*, one of the earliest specimens of this form of bibliography.

His Contributions

Scudder was a prolific writer. His contributions numbered 791. His *Nomenclator zoologicus* (1882–84) though not quite within his special field of study is remarkably thorough and is said to be still of considerable value. His special field was orthoptera. In the course of his life, he named and described 1,884 species, of which 1,144 species and 233 genera are fossil insects. Some of his books like *Frail children of the air* (1895) and *Everyday butterflies* (1899) were in a popular key, dealing with migration, protective coloration and dimorphism; at the same time they were so full of suggestions as to open broad fields of research. His monumental work which embodies the result of thirty years of systematic research is *The butterflies of the Eastern United States and Canada with special reference to New England*. 3 V. (1888–9). His closing years were devoted largely to fossil insects.

His Honours

He received the Walker prize of the Boston Society of Natural History in 1898. He became a member of the National Academy of Sciences in 1877 and of the American Philosophical Society in 1878. He was elected an Honorary Fellow of the Royal Society of Canada and of the Entomological Society of London. He was also a Foreign Associate of many learned bodies in several foreign countries. He has been called "the greatest scholar and the most charming writer among American entomologists".

He died on May 17, 1911, of paralysis which kept him in a disabled condition for nearly fifteen years.

INDUSTRIAL OUTLOOK.

Problems of the Paper Industry in India.

By M. P. Bhargava.
(*Forest Research Institute, Dehra Dun.*)

THE total annual consumption of all kinds of papers and boards in India in 1935-36 was 216,356 tons, as compared with 115,636 tons in 1925-26. In one decade, therefore, the annual consumption rose by about 188 per cent. The attached tabular statement summarises, under the main headings adopted in the trade returns, the quantities of the various kinds of papers and boards made in this country and those imported from abroad in the two years, 1925-26 and 1935-36.

An examination of the table brings out the following interesting facts :—

(1) That the production of Indian mills in the past has been confined mainly to writing and printing papers. In 1935-36, these mills supplied almost 65 per cent. of the country's requirements of these papers.

(2) That the annual consumption of news-prints (papers for printing newspapers) increased from 13,672 tons in 1925-26 to 34,328 tons in 1935-36, *i.e.*, by nearly 251 per cent. This type of paper is not produced in India at all at present.

(3) That the total yearly consumption of packing and wrapping papers, including kraft papers, increased from 37,073 tons in 1925-26 to 77,857 tons in 1935-36, *i.e.*, by about 210 per cent. The whole of the above tonnage is imported from abroad and about 3/4 of it consists of printed unused newspapers.

(4) That the annual consumption of straw-boards, cardboards, etc., increased from 13,191 tons in 1925-26 to 28,175 tons in 1935-36, *i.e.*, by about 221 per cent. The share of the Indian production of these in 1935-36 was about 4,000 tons, or only about 14 per cent. of the total.

(5) That while the Indian production in 1935-36 was 176 per cent. of that in 1925-26, it was only 23 per cent. of the total consumption in 1935-36, as compared with 24·4 per cent. in 1925-26.

In view of the enormous forest wealth of the country, which can be utilised for paper making and of the "protection" extended to the industry by Government since 1925, the dependence of the country to such a large extent on foreign imports would appear to be rather anomalous. In the following paragraphs, the problems which face the industry to-day and which require to be solved in order to enable it to develop to its full stature, are briefly examined. For the sake of clarity and convenience almost the entire field of the consumption of papers and boards is scanned under the following main groups :—

1. Writing and printing papers (better and medium qualities).
2. Cheap printing papers including news-prints.
3. Packing and wrapping papers including kraft papers.
4. Straw-boards, card-boards, paste-boards, etc.

1. Writing and Printing Papers.

It will be seen from the table that the production of these papers by the Indian mills increased in one decade from 25,203 tons in 1925-26 to 43,530 tons in 1935-36. The increased output was rendered possible entirely as a result of the successful investigations by the Forest Research Institute and the Indian paper mills on the production of chemical pulp from bamboos. Prior to 1925, the industry depended mainly on *sabai* or *bhabar* grass (*Ischœmum angustifolium*) as its staple raw material. The available quantities of this grass were not adequate to permit expansion of the industry on an economic basis. In bamboo the industry has found a material, sustained supplies of which are available in abundance in different parts of the country and from which a large variety of writing and printing papers can be produced at an economic cost. The use of bamboo has enabled the industry, with the aid of "protection" granted by Government, to expand and capture almost the entire increase, in the

last decade, in the demand of writing and printing papers, which would otherwise have been met by foreign imports. It is true that over 12,000 tons of writing and printing papers, consisting of superior quality and special papers, *e.g.*, banks, bonds, art, litho, etc., are still imported into the country. These papers could be made from bamboo and other available raw materials, but as the quantity of each individual variety is too small, its manufacture cannot be taken up profitably by an Indian mill, particularly as the distribution of such manufactures over the vast area of India would be uneconomic. Until, therefore, the demand for the individual papers increases considerably, their manufacture in this country is likely to remain uneconomic. Excepting these papers, therefore, India is now in a position to meet not only her present requirements of writing and printing papers but also to supply the greatly increased demands of the future. To enable her, however, to retain possession of this market, it is essential, that research on bamboo, which has already put the industry on its legs, should continue, so that, in due course, the bamboo paper industry can successfully compete, without the aid of "protection", with the long-established and highly advanced wood pulp industry of the West, in which extensive research is still in progress in full vigour. Investigations to this end and with a view to improve continually the technique and lower the cost of production, form an important part of the programme of work of the Paper Pulp Section at the Forest Research Institute at Dehra Dun.

2. Cheap Printing Papers including Newsprints.

The consumption of these papers increased from about 24,000 tons in 1925-26 to about 46,000 tons in 1935-36, *i.e.*, by about 190 per cent. With the advent of the Reforms and the spread of education among the masses the consumption of these papers is bound to increase at a much higher rate in the coming years. It has not yet been possible to manufacture these papers at competitive prices in this country, as in their production a large proportion (70 per cent.—80 per cent.) of cheap mechanical pulp (*i.e.*, pulp made by mechanical processes of grinding without the use of any chemicals) are required, and the production of this kind of pulp from indigenous materials has not hitherto been attempted. The use of foreign mechanical pulp for the manufacture of these papers has not been feasible on account of the heavy protective import duty. Cheap mechanical pulp must, therefore, be made available to the paper-maker in this country in order to enable him to capture the large and growing market for these papers. The Forest Research Institute has already taken this problem in hand. The erection of suitable machinery for carrying out the experimental work is nearing completion and a systematic investigation on the possibility of using bamboos and woods for the production of mechanical pulp is in train.

3. Packing and Wrapping Papers including Kraft Papers.

The use of kraft paper (strong brown paper used for packing purposes, often glazed on one side and rough on the other) on a large scale has only developed in India within the last few years. In 1935-36 the imports of these papers were 9,544 tons. As the use of this paper is likely to grow considerably in the near future, its manufacture in the country offers bright prospects. Recently experiments have been carried out at the Forest Research Institute on the production of kraft paper fron bamboos, the only raw material which is at present available in sufficiency for the purpose. The results obtained are very promising and it is hoped that the investigations, when completed, may establish the possibility of producing satisfactory qualities of kraft papers from bamboos and that their manufacture will soon be taken up in the country.

A remarkable feature regarding the other cheaper varieties of wrapping and packing papers is the enormous consumption of imported old newspapers. In 1935-36, while the import of ordinary wrapping papers was 10,730 tons, that of old newspapers was 57,583 tons or more than double what it was in 1925-26. These old newspapers are, as is well known, largely used for wrapping foodstuffs, fruits, provisions, etc., in bazaars. Such a use is admittedly very unhygienic and detrimental to public health. The price at which the old newspapers are dumped into the country is so low that it is impossible to manufacture any

paper, even from the cheapest material available, to compete with them. In the interests of public health and of the development of a large and new industry it is obviously necessary that the present undesirable use of old newspapers should be discontinued. The only effective measures which can be taken to bring this about are:—Firstly, the production of very cheap wrapping papers in the country. For this purpose it is indispensable that cheap pulp, both chemical and mechanical, should be available to the paper maker. As has been mentioned above, investigations are in progress at the Forest Research Institute to cheapen the cost of production of chemical pulp, and experiments have already been initiated to explore the possibilities of mechanical pulp from indigenous materials. It is hoped that success will attend these investigations and that the manufacture of cheap wrapping papers will become economically possible in the near future. Secondly, it will be necessary to educate public opinion against the use of old newspapers for wrapping up foodstuffs, and lastly it may be found advisable to put a heavy protective duty on the imports of old newspapers, once the possibility of producing cheap wrapping papers in India is fully established.

4. Straw-boards, Card-boards, Insulation-boards, etc.

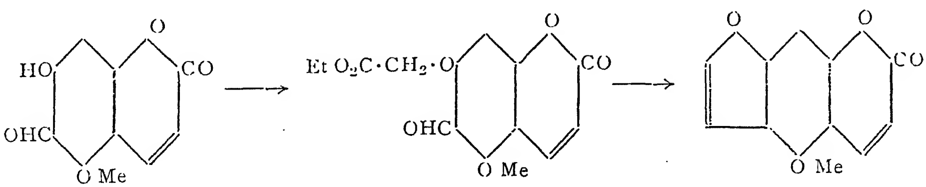
The consumption of boards has more than doubled in the decade ending 1935-36. The Indian production of these products is barely 14 per cent. of the total demand. The smallness of the aggregate demand, and the non-availability of cheap materials such as mechanical pulp or agricultural wastes have principally been responsible for the very slow growth in the manufacture of these products in the country. The phenomenal growth of the sugar industry in the last few years has, however, raised the problem of profitably disposing of surplus bagasse (crushed sugarcane). The Imperial Council of Agricultural Research has recently made a grant to the Forest Research Institute for investigating the possibility of utilising bagasse for the production of wrapping papers, insulation-boards, straw-boards, etc. These investigations are on the point of being started. The availability of mechanical pulp and the utilization of agricultural wastes will, it is hoped, render practicable the establishment of a board manufacturing industry in India, particularly as with the industrial and commercial development of the country, the demand for boards of various kinds is likely to become large enough to enable their manufacture to be taken up on a profitable basis.

To sum up, during the last ten years the consumption of papers and boards in India has increased on the average by about 10,000 tons per annum. With the industrial and economic development of the country and the widespread diffusion of literacy among the masses, the demand for papers, particularly of the cheaper variety, is bound to increase more rapidly in the future. The present *per capita* consumption of paper in this country is hardly $1\frac{1}{4}$ lbs. as compared with 150 lbs. in the United States of America, and is the lowest of all countries in the world, except perhaps China. There is thus an enormous scope for the growth and development of the paper industry in India. A well-organised plan, enterprise and sustained and intensive research are needed to exploit the natural resources and render the country self-sufficient with regard to her requirements of a commodity of vital importance for national development and for the progress of civilisation. Investigations on subjects of immediate industrial importance are, as has been shown above, in progress at the Forest Research Institute. If some other technical institutions and universities in this country, where facilities for applied chemical research exist, also interest themselves in problems connected with these subjects and work in liaison and co-operation with the Forest Research Institute, it would help towards the sound and more rapid progress of one of the major industries of the country. The industry at present employs more than 6,000 hands and the total value of its imports amount to about 3 crores of rupees. If the major portion of these inports is manufactured in India, employment would become available to a considerably greater number of people, and the natural resources of the country would be utilised to the fullest advantage.

Item No.	Description of Papers and Boards	Imports Tons		Made in India Tons		Total consumption Tons	
		1925–26	1935–36	1925–26	1935–36	1925–26	1935–36
1	Writings and Printings including *badami*, envelopes, etc.— (*a*) Protected	8,637	12,095				
	(*b*) Not protected (mostly printing papers)	10,490	11,654				
		19,127	23,749	25,203	43,530	44,330	67,279
2	Newsprints	13,672	34,328	..	..	13,672	34,328
3	Kraft	..	9,544	..	..	..	9,544
4	Packings and wrappings ..	8,805	10,730	Included No.	in item 6	8,805	10,730
5	Old newspapers	28,268	57,583	..	..	28,268	57,583
6	Other kinds	2,382	3,846	3,018	2,181	5,400	6,027
7	Paper manufactures	1,442	2,019	..	..	1,442	2,019
8	Straw-boards	10,933	15,090	..	4,000 (approximate figure)	10,933	19,090
9	Card-boards, Mill-boards, Paste-boards, etc.	2,258	9,085	..	..	2,258	9,085
10	Manufacture of boards	528	671	..	..	528	671
	Total	87,415	166,645	28,221	49,711	115,636	216,356

RESEARCH ITEMS.

A Partial Synthesis of Bergapten.—Howell and Robertson (*J. C. S.*, 1937, 293) have recently confirmed the accepted structure of bergapten (III) by synthesising it from *apo*xanthoxyletin (I), the orientation of which has been established by Robertson and Subramaniam. (*loc. cit.*, p. 286). (I) on condensation with ethyl bromoacetate in acetone containing potassium carbonate gave the ester (II). The corresponding acid yielded, on cyclisation and simultaneous decarboxylation with acetic anhydride containing sodium acetate, a product (III) identical in every respect with natural bergapten. The parent coumarin of (I) has also been synthesised but its conversion into (I) has not yet been achieved.



(I) (II) (III)

T. S. W.

Haematoporphyrine as a Cure for Melancholia and Endogenic Depression.—The efficacy of Hæmatoporphyrine in the treatment of certain mental disorders is recorded by Dr. Jakob Huehnerfeld who has experimented on the method for the last seven years (*Forschungen und Fortschritte*, 1936, 12, 343).

These experiments were commenced in 1929 on animals and later confirmed by Dr. Huehnerfeld and co-workers by clinical experience of patients suffering from melancholia and endogenic depression. It was established that Hæmatoporphyrine acts firstly photo-dynamically, secondly as a stimulant and lastly as a regulator of normal animal metabolism. This threefold action is responsible for the increased appetite, better physical appearance, sparkling eyes and the increased general activity of the patient. Objectively, the calcium, potassium and sugar contents of the blood as also its pH value become more normal. An increase in the Hæmoglobin content of the blood is also noticeable. Extensive clinical experience with over 400 patients have convinced Dr. Huehnerfeld that Hæmatoporphyrine is the specific casual agent responsible for this improvement.

The optimal dosage is 500–700 mg. of Hæmatoporphyrine spread over a period of 40–60 days. No secondary complications were noticed. Hæmatoporphyrine is already marketed in Germany under the trade-name " Photodyn ".

EMMENNAR.

Alba—a New Palladium-Silver-Gold Alloy.—Dr. Alfred Jedele of Hanau describes in *Forschungen und Fortschritte* (1937, 13, 95), Alba, a new palladium alloy which can well replace the usual gold compositions extensively used in dentistry and in the manufacture of fountain pen nibs. The alloy has the approximate composition of 30 per cent. palladium, 60 per cent. silver, 5 per cent. gold and smaller proportions of other (undisclosed) constituents. The molten alloy is quite mobile and easy to work with. And apart from the fact that the sp. gr. of the alloy is about 25 per cent. less than that of 20-carat gold, the E_h potential of the alloy against lactic acid is about the same as that of the gold alloys hitherto employed in dentistry, so that the use of dentures made of the new alloy along with existing " gold " plates does not lead to any corrosion or discoloration.

The economic value of the new alloy to Germany handicapped for want of adequate foreign exchange resources can be gleaned from the fact that that country consumes annually for dentures alone 4000 Kg. of gold, all of which has to be imported. The use of the substitute alloy Alba in place of the gold alloys would save the country, it is estimated, nearly 74 per cent. in import costs.

EMMENNAR.

Biochemistry of *Sonti* Fermentation.—In Eastern countries, a large variety of alcoholic beverages and liquors are prepared by symbiotic fermentation of rice, the symbionts being usually a fungus and a yeast. The *Sonti* fermentation (K. Rami Reddi and V. Subrahmanyan, *Trans. National Inst. Sci.*, 1937, 1, 293–331) which is practised in some of the Andhra Districts of the Madras Presidency belongs to this class but presents certain unique features which distinguish it from other fermentations of its type. The chief object of the fermentation is to produce a highly digestible form of rice, particularly suitable for infants and invalids. An analysis of the product (*Sonti annam*) shows that it contains very little starch but is chiefly made up of sugars and dextrins together with small quantities of organic acids, esters and alcohol. The organism chiefly responsible for the digestion of rice is a hitherto undescribed species of *Rhizopus* (tentatively named *R. sontii*) characterised by its powerful amylase which is particularly effective on rice starch. The other organisms associated with the fermentation—*Dematium* sp. (?), *Saccharomyces cerevisea*, *Torula* sp. (?) (*Torula Hansen ?*) and *Micrococcus perflavus*—have also been described. The influence of various factors on the course of fermentation have been studied and particular attention drawn to the fact that under certain conditions, very high yields of alcohol can be obtained. The significance of the fermentation in relation to public health and its possible industrial applications have been indicated.

Genetical and Cytological Studies of Hybrids.—Interesting findings are reported by F. A. E. Crew and P. C. Koller (*Proc. Roy. Soc. Edin.*, 1936, **56**, Pt. 3, 210) who have examined the behaviour of the intergeneric hybrid of *Cairina moschata* and *Anas platyrhyncha platyrhyncha*. It has long been known that these genera are fertile *inter se* but their hybrid is infecund. The progeny of *Anas* female and *Cairina* male consists of abnormal and infecund males and females, while the progeny of *Anas* male and *Cairina* female consists of infecund males and females with normal sex behaviour. A number of cytological abnormalities were noticed in the hybrid, like chromatid bridges and fragments, precocious activity of some dot-chromosomes, formation of giant cells with multiple nuclei, degeneration of cell due to vacuolation, etc. But the sterility of the hybrid is mainly due to the abnormal development and behaviour of the spindle, for, the parental chromosomes in the hybrid show every sign of regular pairing during meiosis, the metaphase plates of which become disarranged due to spindle abnormality.

A New Pelagic Larval Ceriantharian.—N. K. Panikkar (*Zool. Anz.*, 1936, 115, 9/10, 250), has reported the occurrence of a larva belonging to a species of Ceriantharian which he has called *Apiactis bengalensis* in the waters off the coast of Madras. A tiny animal, not exceeding 3 mm. in length, the larva has certain distinctive features which separate it from the allied *A. denticulata* and *Isapiactis obconica*. From the former species it differs in the size and arrangements of the marginal tentacles as well as in the thicker mesoglœa and the absence of craspedonemes while from the latter it differs in regard to the acontia and the directive tentacles. The position of the new species with reference to the two above forms is discussed at the end of the paper.

Need for a Soil Survey of India.

A DISCUSSION on the need for A Soil Survey of India was held during the Indian Science Congress Week at Hyderabad (Jan. 1937), Rao Bahadur B. Viswa Nath presiding.

In introducing the subject the President stated that the answer to such a general proposition as "the need for a Soil Survey", would undoubtedly be in the affirmative: but the point for consideration was about the type of Survey. In arriving at an answer to this question, it would be necessary (1) to consider the objects of a soil survey, (2) to ascertain what had already been done in India and what was being done and (3) to define what was wanted. A soil survey could be carried out for one or more of many purposes. For example, it could be carried out for settling new land. It could be carried out for ascertaining the physical and chemical characteristics of the soil with reference to manurial treatment, and irrigation projects. In regard to the first point there were about 150 million acres of cultivable waste land. All this land was, however, not situated in one compact block but was scattered in small patches all over India. It was necessary, therefore, in the first instance to ascertain the nature and the disposition of the waste land and this would perhaps form a subject of enquiry by the Departments in the Provinces. During the past quarter of a century soil surveys were in progress in the different parts of the country to ascertain the manurial and fertiliser requirements of the soils. As a result, a considerable amount of valuable data were obtained and these were being used in advising on manurial programmes and fertility projects. In recent years, enquiries had been commenced in connection with irrigation and drainage problems with a view to ascertain the most suitable alignment for irrigation and drainage channels. There remained, therefore, the survey for the classification of soils so that the information obtained would be useful in interpreting the response to manurial treatments and for research and advisory work. They had, therefore, to consider carefully what methods of survey were needed for this purpose.

In England the basis of classification in the early days was geological, the assumption being that each geologisal variation gave rise to its own type of soil. Subsequently this was not found to answer the purpose, as the effect of climate, altitude, topography and other factors was considerable, so that soils formed from the same geological parent material varied considerably. Then there was the Russian and American methods of classification which were chiefly based on the study of the soil profile.

The soils of India could be very broadly classified into the Indo-Gangetic alluvium covering about 300,000 sq. miles: the tract of black soils covering a total area of about 200,000 sq. miles, and a red soil tract including laterite soils of 150,000 sq. miles. The black soils, although derived from different basic materials, possessed common agricultural characteristics and a silica alumina ratio between 3 and 4. The large tract of Indo-Gangetic alluvium was almost alluvial in nature. The soil profile in this case did not appear to be so important as it was elsewhere, but surely it should be possible to differentiate profiles even in this huge block of alluvium with reference to the relative intensities of rainfall, evaporation and temperature. The ratio of rainfall to temperature for the different parts of India varied from 0·10 to 1·5. A broad classification of areas might be made into

North-east India,
North-west India,
North Central Alluvial India, and
Peninsular India,

which again could be subdivided on the ratio basis and classified with respect to texture and composition.

He would be glad if speakers would kindly bear in mind these points and confine their remarks to the methods of survey that might be considered necessary on an All-India basis.

Messrs. Wadia and Roy spoke emphasising the geological aspect of soil survey. Dr. Puri discussed the means of approach to the problem and the methods to be employed and suggested that a committee of people engaged in soil survey should draw up an agreed programme of work and co-ordinate results. Mr. Wad said that valuable data are available from Settlement Surveys and that they should be examined and utilised. He gave data collected by him in Central India. Rao Saheb Bal spoke with reference to the soils of the Central Provinces and Dr. Kasinath on the soils of the Madras Presidency.

In the course of his address SIR JOHN RUSSELL said that he would confine himself to indicating various directions in which local surveys can profitably be made.

In regard to the cultivable wastes of 150 million acres mentioned by Mr. Viswa Nath, one cannot help feeling that there is a good deal of it that could even in present conditions be brought into cultivation, and one advantage of a survey will undoubtedly be that it will enable us to ascertain which are the most promising areas for reclamation.

In regard to manurial experiments a good deal of information had already been obtained and this will be extended now that modern methods are so widely being used. A soil survey in relation to the area served by the experimental station affords an effective method of showing how far the experimental results are likely to be applicable in practice.

Further, there is the problem of Irrigation. I attach great importance to making a proper survey of any region that it is proposed to irrigate. Trouble from water-logging is likely to follow irrigation unless the scheme has been planned as guided by a previous soil survey. I could give instances from different parts of the world which I have visited where the scheme considered from the engineering point of view has been admirable, but from the soil point of view it was bad.

Coming now to the important problem of classification, several methods have been used. The earliest was textural. Then came the geological

basis: then climatic. then the profile basis. All are useful. but objection can be taken to all of them. Geological data, however. are invaluable for providing information in respect to water-supply, where it is essential to know the nature and position of the various strata. their permeability and their relation to the ultimate supplies of water. Studies of this kind would be useful in famine areas.

Other problems of soil survey arise in connection with forestry. Forest conservation is an effective way of reducing or even preventing soil erosion.

Problems connected with laterite soil and black cotton soils offer exceptional scope for study in India.

One of the modern methods of soil survey is to have it on the soil profile. Unfortunately, most of the Indian soils I have seen have no very marked profile such as can be seen in other parts of the world. A good deal of soil work is being done in India and it would undoubtedly be a great advantage to put all local surveys on to a uniform basis so that the results can be collated and brought together. it is not necessary to adopt any one basis of classification. Soil investigators are by no means agreed on the matter, and numerous systems have been proposed. The important point at the present time is that the soils should be fully described and that the same methods of description should be used by all Indian workers. Dr. Puri's suggestion is sound that the Indian soil workers should constitute a committee to draw up an agreed basis for describing the soils and should indicate the methods of examination to be adopted. It would further be necessary to arrange for some central body or for some institution to collate the results and prepare the maps and so to put data on record that will be useful to all concerned with soil management and with agriculture.

Mr. Champion read a note prepared by Dr. Gorre with reference to plant cover and said that before deforesting soils for agricultural purposes, sufficient consideration should be paid to the soils, protective and water storage aspects of the natural plant cover.

Practically all sloping grounds in the drier parts of India are of some importance as a source of water to the plains dwellers either for irrigation, town water or electric power, and its efficiency in catching and storing water depends very largely on how for the natural soil profile has been maintained and developed by preserving the natural plant cover.

I submit that any form of soil survey which may be taken up should cater for this method of land. use. The survey should register the relative efficiency of the existing plant cover in maintaining the optimum soil profile, and it should also indicate whatever changes are taking place in the building up or degradation of the existing profile. The view-point which regards soils *in situ* as entirely static and permanent will fail to give a record of permanent value because in many areas the soil profile is being rapidly destroyed through bad agricultural and pastoral practices. The soil survey must take cognisance of this fact and one member of each mapping party should be sufficiently erosion-conscious to be able to record obvious tendencies of this nature. The cumulative denudation which is taking place in many parts of the western provinces is leading inevitably to desiccation. By this I do not infer that the total rainfall is being appreciably reduced, but that the ground is being rendered less capable of absorbing the available rainfall.

Blood Substitutes.

THE blood of Vertebrates remains one of the most baffling of animal fluids. While its constitution is fairly definitely known, it has as yet been impossible to simulate it or provide an efficient substitute for it. And seeing that almost every day the need for an adequate substitute for blood is felt by the doctor, by the physiologist and by the biologist, it appears that our efforts to provide them with a successful blood substitute need to be intensisfied.

The literature on the subject is vast and extensive. With a view to find a working substitute for blood because of its great importance in clinical practice, biologists, chemists and medical men have been trying for a long time to systhesise a substance which may take the place of this fluid in the Vertebrate body. History goes back to the middle of the last century when the first attempts were made to replace the blood of frogs by salt solution. Since then the accumalation of literature has become very extensive; W. R. Amberson[1] has recently provided an illuminating review on the subject.

The first and foremost point of importance to be remembered in the study is that there has to this day been no complete substitute for bloods. In all the substitutes so far known some constituent of normal blood must be present. Nor is it possible to imagine,—let alone make,—a substitute for hæmoglobin. All our efforts must therefore rest in an attempt to make but the vehicle in which must be present hæmoglobin. either in a state of suspension or in the form of red cells.

A variety of conditions are to be fulfilled if a substitute for blood can be practicable, the most important of which are the ability to maintain an adequate pressure and volume and a tendency of the materials constituting the fluid not to leave the blood stream. These two are indeed the prime difficulties in the making of any fluid substitute for blood, for in many of them, either the required volume and pressure are not maintained or else, the materials of the fluid tend to leave the blood stream quickly,—very often in the course of a few hours.

Red cells are not a necessary constituent of blood but hæmoglobin in solution must be present; then, blood will be performing the dual function of maintaining the osmotic pressure and carrying oxygen,—a duality not found in any vertebrate,

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[1] *Biol. Rev.*, January 1937, **12**, No. 1, 48.

though in many invertebrates where the hæmoglobin is in solution, this is possible. Experimental evidence shows that in vertebrates, this condition of dissolved hæmoglobin in blood is not workable, for hæmoglobin tends to leave the blood vessels quickly, passing into lymph to be taken up by the cells of the reticulo-epithelial system. It also becomes changed into methemoglobin so that it is not possible to maintain life after 36 hours.

Of the blood substitutes to be considered here, the most ancient but the least efficient are solutions of crystalloids which are apparently useless as substitutes as they leave the blood stream quickly and are unable to maintain blood volume and pressure. Isotonic sodium chloride solution with or without the addition of citrates and lactates has been used extensively and while differences of opinion still exist regarding the efficacy of these solutions, it is almost certain that none of these solutions can maintain life.

The next in importance are substitutes like blood plasma and blood serum which contain sufficient colloidal material to give osmotic pressure approximating to that of normal blood. Of these, blood plasma is preferred to blood serum on account of the fact that in the latter vaso-dilator and constrictor substances are found in the act of clotting.

The only effectve and practical substitute are carefully prepared gum-saline solutions with suspended, washed red cells from the same species. First used by Carl Ludwig (1863), the importance of gum-saline substitute was realised during the Great War when large quantities were used in clinical practice. Gum-saline has a number of inherent difficulties which greatly minimised its importance. The great sedimentation rate caused by it and the tendency of gut to coat the red cells thereby reducing their ability to combine with oxygen are two of the most outstanding. Added to this, there is evidence to show that gum leaves the blood stream and cannot maintain the colloidal osmotic pressure longer than 48 hours and that gum tends to get fixed in certain organs, especially the liver, thereby diminishing the concentration of the plasma proteins by blocking the liver. But these are comparatively minor difficulties and the author's own researches lead him to conclude that next to blood plasma this is the most effective substitute and in hospitals and clinical laboratories all over the world, the use of gum saline is on the increase. Gelatine saline which has sometimes been used is incapable of acting as a substitute because gelatine leaves blood quickly and it tends to hasten coagulation and intravascular clotting.

SCIENCE NOTES.

Wood is Good.—(*Bulletins of the Timber Development Section of the Forest Research Institute, Dehra Dun*) by S. Kamesam, M.I.E., with a Foreword by H. Trotter, Dehra Dun, 1936.

The *raison d etre* for this series of Bulletins is best summarised by Captain Trotter in his Foreword to the series as follows: "In the past, steel and concrete have been looked upon as the chief structural materials of the engineer. This has been due to the fact that these two materials have been widely advertised and strongly assisted by powerful organisations, whereas wood being nobody's child has gone by default."

Though the Bulletins are frankly propagandist, it is recognised that "there is a right and wrong place for everything....All we ask is that it should be given a fair hearing....".

In more advanced countries, organisations like the Timber Development Association of England undertake this kind of propaganda. In the absence of any such institution in India, the Forest Research Institute is devoting more attention to this aspect of publicity work none too early; for, on account of the persistent, intensive and subtle advertising campaigns by rival structural interests, timber has a lot of leeway to make up.

The Bulletins are singularly free from abstruse technical terms and what is perhaps more important from overstatements and exaggerations. The crisp narrative is all the more effective on account of its direct simplicity. One could however wish that the get-up of the Bulletins were more in consonance with the large stakes involved in the adequate ultilisation of Timber.

"Wood is Good" Bulletins supplement and form a very necessary counterpart to the technical publications of the Forest Research Institute.

EMMENNAR.

* * *

The Preparation of Alumina and Sulphur-Dioxide from Bauxite Gypsum Mixtures.—[By V. S. Dube, M. B. Rane and M. Kanakaratnam. *Bulletins of Indian Industrial Research*, 1937, No.6.]

This paper describes the results of experiments in which mixtures of bauxite and gypsum in different proportions were heated to temperatures ranging from 1000° to 1280° for periods varying from 2 to 8½ hours. 2 g. of the bauxite were employed in each experiment (except in one experiment, wherein 5 g. were taken), and the proportion of bauxite to gypsum in the mixtures ranged from 3 : 1 to 1 : 3. The furnace employed for the work was of the coal-fired muffle type and is reported to have been maintained at the required temperature for a specified time with a variation of not more than 10°.

It was found that the reaction between bauxite and gypsum was appreciable at 1000° and complete at 1250°. The most suitable conditions for the preparation of alumina from bauxite and for the complete explusion of sulphur trioxide from gypsum were found to be present when mixtures of bauxite and gypsum in the ratio of 2 : 5 were heated to 1200°–1250° for a period of 6 to 7 hours.

K. R. K.

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The Jewish Communities of Cochin, India; their Racial Affinities.—At the ordinary monthly meeting of the Royal Asiatic Society of Bengal, held on Monday, 5th April, ELEEN J. W. MACFARLANE

gave a paper on *Racial Affinities of the Cochin Jewish Communities*. The Jews of Cochin totalling 1,451 in 1931, are divided into 2 endogamous communities, the White and the Black Jews. The White Jews are a minority of under 150, claiming origin from Palestine in the first century A.D. They aver that the Black Jews are the descendants of Indian convert slaves of their ancestors, and are not of the Jewish race. The Black Jews declare that they are descended from Jews who came from Palestine before the Christian era, and explain their brown skins by a long sojourn in the Tropics; according to them, the White Jews are new arrivals within the past 400 years. In order to throw light on this controversy, serological data were obtained. They show that the distribution of the blood groups in the two communities is entirely dissimilar. The White Jews show 62 per cent. Group A. This is due to inbreeding for the two largest families, who have intermarried frequently, are now apparently homozygous for gene A. The Black Jews show a disproportionate high percentage of Group O—73.6 per cent. This group was found to be very high among the low castes and outcastes of Cochin. Native slaves and concubines would come from these poor classes, and the chances are 7 to 3 that a low class woman will carry the recessive gene R of Group O. Additions to the community have evidently taken place from Group O persons. Physically the Black Jews resemble the local Moplah Mohammedans who are descended from Arab traders and local women. Consideration of the judgment of the Great Rabbi concerning the Black Jews and of the blood grouping and physical anthropology of Jewish communities in other parts of the world shows that Judaism is a culture and not a race in the biological sense. Jewish people in different regions are dissimilar in racial make-up. In Cochin, social classes have become endogamous castes. Since the Jews are patriarchal, children belong to the father's race, the Black Jews are right in contending that they are "True Jews".

The other papers read at the meeting were:—J. C. De: *The Development of the Theory of the Divine Nature of Kings in Assam.* K. Krishan Nair: *An Abnormal Specimen of* Silures Cochinchinensis *cuv. and val. showing Eversion of Stomach into the Pharyngeal Cavity.* D. D. Mukherji: *An Abnormal Brown Trout* (Salmo fario *Linn.*) *showing Eversion of Stomach into Pharyngeal Cavity.* M. H. Kyaw and G. E. Gates: *The Earthworm Populations and the Formation of Castings in Rangoon, Burma.* Kalipada Biswas: *Common Diatoms of the Loktak Lake, Manipur, Assam.* K. Sen: *Some Notes on Tural Customs of Dinajpur District.*

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Nutrition Research in India.—Considerable interset is being taken by official and unofficial organisations concerned with the health and well-being of the people in the scientific study of human nutrition in India. Hitherto the view that malnutrition is prevalent has rested on *a priori* reasoning, on general knowledge of conditions prevailing in the villages and poorer quarters of towns and cities; on scattered observations regarding the existence of food deficiency diseases; on animal experiments and on pronouncements of experts, rather than on exact data collected by systematic research (says a press communique issued by the Director of Public Information under date 5-4-37). Research in India is now being organised for the collection of these fundamental data, which will enable the whole problem to be defined and clarified, and vague general statements replaced by precise knowledge. The principle centre of research on nutritional problems in India is Coonoor, where during the past 15 years pioneering work on the various aspects of the science of nutrition has been carried out. A systematic survey of nutritive value of some 200 common Indian foodstuffs as regards their content of calories, proximate principles, calcium, phosphorus and iron was recently carried out. The Vitamin A and carotene content of some 160 foods have also been investigated and a similar number of foods have been examined for their Vitamin C and about 50 for Vitamin B_2 content. Dietary Surveys are being carried out by the Coonoor and Calcutta Research units and attempts are being made to study the effect on health and physique of various types of diet. Enquiries into the "state of nutrition" of children in day schools of South India have shown a widespread prevalence of malnutrition and symptoms of food deficiency diseases are very common. Basal metabolism enquiries are being carried out and the results will be of value for establishment of standards of calorie requirements. It is proposed to select and train workers for various provinces for nutritive work and with the help of such workers attached to Public Health Departments, it will be possible to determine the height-weight-age averages in different social groups; to detect malnutrition in schools; improve the dietary; to plan institutional diets, and organise propaganda work in towns and villages.

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Researches on Lac.—A copy of the *Report of the Indian Lac Cess Committee* for the first quinquennium ending 31st March 1936 has just been published. This heralds the publication of annual reports of the committee hereafter, in accordance with the Committee's recent decision. The *Report* contains a brief account of the work done by the Indian Lac Cess Committee during these five years, in order to safeguard the interests of the Lac Industry in India. To meet the situation, biochemical work has been considerably curtailed and much more attention is bestowed upon the standardisation of the lac products and their utilisation in Industry.

Reference is made to the increase in the lac cess with the object of enhancing the finances of the Lac Cess Committee and to the reconstitution of the Committee on the lines of the Imperial Council of Agricultural Research. The detailed statements of the receipts and expenditure for the five years indicate that increasing amounts of money are furnished for research activities in India and abroad to consolidate the position of lac. Notes on the production of lac and the trade in lac are also incorporated in the report.

A succinct account is given regarding the researches on lac products in the Indian Lac Research Institute, and in the United Kingdom under the ægis of the London Shellac Research Bureau. The initiation of co-operative research

on the uses of lac in the electrical industry at the laboratories of the Metropolitan-Vickers Electrical Co., and on its use in rubber goods at the Research Association of British Rubber Manufacturers should prove of great value to the development of the Lac Industry.

The report concludes with a useful and exhaustive list of publications of the Indian Lac Research Institute and the London Shellac Research Bureau which cover all aspects of lac research—biochemical investigations, cultural practice, and industrial applications.

A. V. S.

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The Botanical Society of Bengal.—The First Annual Meeting of the Society was held on the 4th March in the Botanical Laboratory, Calcutta University, Ballygunj Circular Road, Calcutta. Prof. S. P. Agharkar, Vice-President of the Society, presided.

The Council's report for the year records an all-round progress in the work of the Society. The number of ordinary members on the rolls was 65. The Society organised 9 scientific meetings during the year at which 10 original papers were read and discussed. Popular lectures and excursions were also organised, and during the coming year, it is proposed to organise excursions to study the local flora and collect materials.

Prof. S. C. Mahalanobis was elected President of the Society for the coming year, and Dr. G. C. Sengupta and Mr. A. K. Ghosh were elected Hon. Secretaries.

A botanical exhibition and conversazione were organised on the occasion, and Prof. S. P. Agharkar delivered a popular lecture on the " Flora of Nepal ".

* * *

The Indian Associaton for the Cultivation of Science.—The appendix to the *Annual Rep rt* for the year 1936, which has just been published, gives a short account on the scientific work of the Association. The work has been classified under: Absorption and Fluorescence spectra of Organic Substances; Optical Studies on organic crystals; Magnetic studies on organic crystals; Approach to absolute zero of temperature; The magnetic anisotropy of paramagnetic hydrated crystals; Magnetic studies on graphite; Diamagnetic susceptibilities of organic substances in different physical states; Studies on magnetic double refraction; X-Ray studies on the structure of crystals; Refractivity and dielectric constant; Maxwell effect in liquids and studies on constant paramagnetism. The Association has a very high established tradition as a centre of Physical Research in the country. 54 papers were published in the *Indian Journal of Physics* during the year.

* * *

Institution of Chemists (India).—The annual Meeting of the Institution was held on the 27th February at the University College of Science and Technology, Calcutta. In the course of his Presidential Address Mr. N. N. Sen Gupta dealt with the work of the Institution during the past nine years of its existence and suggested the initiation of fresh activities which will bring it " visibly nearer the achievement of its declared object ". The institution has served as the association for Applied Chemistry in India and " is capable of rendering important service to the cause of applied chemistry". The President stressed the " possibility of active co-operation between the institution and the Indian Chemical Society, in fact among all chemical associations which may eventually arise in this country so that a representative chemical block, such as the Chemical Council of Great Britain may supervise the activities of the various societies ".

* * *

Prof. Birbal Sahni, D.Sc., Sc.D., F.G.S., F.A.S.B., F.R.S., the distinguished Indian Palæobotanist, will shortly proceed to Moscow, to attend the 17th session of the International Geological Congress, which will come off in July next. He has accepted the invitation of the Congress to take part in the symposium on Palæoclimates. At a recent meeting of the Council of the Lucknow University, Prof. Sahni was appointed a delegate of the Lucknow University. He will also represent the Indian Academy of Sciences, at the Congress.

Prof. Sahni, a distinguished student of Prof. A. C. Seward, is well known for his contributions relating to the studies of extinct plants which have led him into the domian of geology. His scientific achievements which deal largely with the floras—past and present—of India and of the Southern Hemisphere, are marked by a broad philosophical outlook and intensive field researches. He was one of the Vice-Presidents of the International Botanical Congress, Cambridge (1930), and again of the Sixth Congress, Amsterdam (1935).

* * *

The degree of **Doctor of Science of the London University** has recently been conferred on Dr. S. Ramachandra Rao, M.A., Ph.D., Professor of Physics, Annamalai University. Prof. Rao has made a number of contributions to the study of magnetic properties of colloidal particles of metallic elements. We offer him our warmest congratulations.

* * *

Improvements in Cotton.—The *Annual Report* of the Indian Central Cotton Committee for the year ending 31st August 1936, which has just been published, gives a reasoned account of improvements in cotton production, the extension of improved types into general cultivations, and in the marketing conditions and manufacture of Indian cottons. Valuable information has been collected as a result of investigations into the possibilities of growing cotton of long and medium staple in the present short staple cotton areas of India. As a result of the exhaustive work carried out under the auspices of the Committee it has now been possible to control the Pink Boll-worm pest which was responsible for the destruction of 25–50 per cent. of the crop in the United Provinces. The United Provinces Cotton Pest Control Act requires all cotton seed, meant for sowing, to be subjected to heat treatment. During the year, the Committee financed 29 research schemes, and 17 seed extension and marketing schemes, the total amount sanctioned being Rs. 5,75,000. Several interesting problems bearing on the physical and chemical properties of cotton are being investigated at the Technological Laboratory, whose facilities are being considerably availed of by millowners who send

a large number of samples for testing. Much valuable work in general botany, physilolgy and genetics of cotton is in progress at the Institute of Plant Industry, which was established in 1924, to serve as a central research station for cotton in the black soil area of Malwa plateau. The Publicity Department of the Committee has done very valuable work in the dissemination of knowledge relating to the culture and industry of Indian cotton not only in the towns and cities by keeping the press well posted with the efforts of the Committee to improve the yield, quality and money-value of cotton, but also in remote villages of India to afford facilities and advice to the Indian cotton grower.

* * *

Scientific Research in Industry.—The Advisory Council of the Department of Scientific and Industrial Research, of which Lord Rutherford is the Chairman, directs attention in the Department's *Annual Report* just issued (H. M. Stationery Office, 3/- net) to important developments in the outlook of industry in Great Britain. The last five years have witnessed, the report states :—

"the fruition of the policy adopted by several large industrial undertakings of setting well-balanced teams of research workers, including chemists, physicists, engineers and where necessary biologists to solve a particular problem or to develop a new product. This method of attack has led to the steady improvement of the efficiency of electric lamps, to the position this country has won in high-definition television, to the development on a commercial scale of the huge plant for the conversion of coal into oil by hydrogenation, to the growth of the plastics industry and to many other important advances. This country has never been lacking in men of genius whose inventive capacity can give birth to the ideas which bring about industrial advances. What is new, in this country in present times, is the way in which industry has taken up these new ideas and brought them to the stage of industrial application by team work in which the scientists, the technical men and in fact all the departments into which a great business is organised have worked side by side in the practical attainment of an objective."

The future, the report continues, no longer lies with industries content to make sporadic advances at the call of the brilliant individualist. Co-operation, team work and an extensive organisation on the technical side are essential for success.

* * *

The Total Solar Eclipse of June 8, 1937.—One of the largest and most completely equipped expeditions ever organised to study a total eclipse of the sun will be sent by the *National Geographic Society* and the *U. S. Navy* to observe the unusual solar eclipse of next June 8 from a tiny coral atoll in the Phoenix Islands far out in the midst of the Pacific Ocean.

This will be the longest eclipse of the sun visible from the earth in 1,200 years, having a maximum duration of totality of 7 minutes and 4 seconds. This eclipse also will "end the day before it starts". Its path will cross the International Date Line in the mid-Pacific, so that it will begin on June 9, but end on June 8.

The scientific leader of the expedition will be Dr. S. A. Mitchell, Director of Leander McCormick Observatory, University of Virgina. Captain J. F. Hellweg, Superintendent of the U. S. Naval Observatory, will have charge of the Navy's participation. Other members of the group will include: Dr. Paul A. McNally, Director of Georgetown College Observatory; Dr. Heber D. Curtis, Director of the University of Michigan Observatory; Dr. Floyd K. Richtmyer, of Cornell University; Dr. Irvine C. Gardner, National Bureau of Standards; Mr. John W. Willis, of the Naval Observatory, and a photographer from the National Geographic Society. A naval surgeon qualified to carry out the work of a naturalist probably will join the party at Hawaii.

The expedition's scientific programme will be one of the most complete and comprehensive ever carried out by eclipse observers. Special attention will be devoted to observation of the sun's corona, visible only during a total eclipse, and the chromosphere, or outer layer of the sun, by photographing the "flash spectrum," which permits the determination of the heights to which vapours rise from the surface of the sun.

Dr. Gardner will take with him the same eclipse camera of his own design which he took to Russia, which employs a new type of lens and with which he obtained very successful photographs of last June's eclipse. He also will make photographs in colour. The Naval Observatory party will be especially interested in observing the exact times at which the eclipse begins and ends. This will serve as an important check on calculations of the movements of the heavenly bodies, which is the official function of the Naval Observatory and which aids it in perfecting knowledge of the motion of the moon and hence in predicting the time of future eclipses.

The National Broadcasting Company, co-operating with the expedition, will set up a radio transmitting station in the island and by short-wave radio, a description of the eclipse will be carried to the United States, sent over a coast to coast network and rebroadcast to other parts of the world.

* * *

Rare African Birds.—An expedition to study and photograph the Crowned Hawk-Eagle of South Africa, which is, for its size, one of the most ferocious and evil-looking birds in the world, will be conducted under the auspices of the *National Geographic Society*, by Captain C. W. R. Knight, of England. The expedition will spend approximately five months in the field, and will make photographic studies of other unusual birds and small mammals of South Africa.

Captain Knight discovered a region, in which Crowned Hawk-Eagles nest during a trip into the back country of South Africa several years ago. The birds have a lesser wing-spread than some of the eagles that live in open country, and more rounded wings, permitting them to manœuvre in forest country. They have unusually large and powerful feet with which they kill surprisingly large animals, even small deer. The birds have been called "the ogres of Africa's monkeys," and under their nests in lofty yellow-wood trees are found many skulls of these creatures. In

order to obtain photographic records of the birds, Captain Knight and his assistants will have to construct blinds in trees near their nests, perhaps 80 to 100 feet above the ground; or on cliffs, if the situation of the nest permits. In these blinds long vigils will be kept with still and motion cameras equipped with telephoto lenses. An effort will be made to obtain a complete photographic record of the lives of the birds from the time they are hatched until they take to the air and begin to prey on the animals of the surrounding country.

Another unusual South African bird to be studied and photographed by Captain Knight is the Hommer-Kop (Hammer-Head), a smallish brown bird about the size of a pheasant, belonging to the stork tribe. The most interesting thing about the Hommer-Kop is its little-known nest, a huge affair like a cart-load of sticks, but with entrance tunnel and "apartments" carefully plastered with hard-setting clay.

Still another unusual feathered creature that will come before Captain Knight's camera lenses is the Secretary Bird of Rhodesia which is fast becoming rare. A member of the vulture tribe with stiltlike legs, this bird kicks snakes, lizards, and moles to death, then swallows them whole.

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International Brewing Abstracts.—With daily duties claiming attention and a voluminous technical press publishing thousands of new papers every year, brewers and brewery chemists must find it increasingly difficult to keep track of the latest developments in the principles and practice of their profession. It is to meet this difficulty that International Brewing Abstracts (I.B.A.) has been evolved. I.B.A. publishes every month some twenty abstracts of the most significant papers in the current journals; these abstracts are each printed on separate cards for filing and bearing index numbers, the system being designed to make instantly available in card-index form a rapid and condensed survey of current information available on all aspects of brewing. The original German edition (*Kartothek der Brauerei-Literatur*) which has been running under the direction of Dr. F. Kutter since 1928, has met with widespread appreciation that the publishers, after launching a French edition in 1934, have begun to issue the English edition now under notice. The Wahl-Henius Institute, Chicago, and a number of English, French, German, Danish and American brewing technologists, collaborate in its production. There is no lack of testimony to the value of this thoroughly practical abstracting service, which should prove as useful to English-speaking brewers and brewery chemists as it has done to those abroad. —(*J. Institute Brewing*, 1936, **42**, 445.)

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Fossil Wood.—Recently a fossil wood from Nowgong Forest Division in Assam has been identified as a species of *Gluta*. Geologically the fossil wood is said to be of Tertiary age—an age which goes back to as many as 60 million years. In this connection it is of interest to note that *Gluta* does not now grow in Assam—its distribution in India being confined to Burma and South India. From the fossil woods that have been so far found it appears that once upon a time there was an extensive forest of *Gluta* in Burma, Assam and Bengal. Why and how this has disappeared from the two latter provinces is a mystery. Perhaps the ecologists will be able to throw some light on this problem. (*Indian Forester*, 1936, **63**, 167.)

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We acknowledge with thanks the receipt of the following:—

"Nagpur Agricultural College Magazine," Vol. 2, No. 2.

"Agricultural Gazette of New South Wales," Vol. 48, Nos. 2 and 3.

"Journal of Agricultural Research," Vol. 53, No. 11.

"Monthly Bulletin of Agricultural Science and Practice," Vol. 28, Nos. 2 and 3.

"Journal of Agriculture and Live-Stock in India," Index to Vol. 5.

"Allahabad Farmer," Vol. 11, No. 2.

"Journal of the Royal Society of Arts," Vol. 85, Nos. 4396–4400.

"Biochemical Journal," Index to Vol. 30 and Vol. 31, No. 2.

"Journal of the Indian Botanical Society," Vol. 16, Nos. 1 and 2.

"Chemical Age," Vol. 36, Nos. 921–925.

"Journal of Chemical Physics," Vol. 5, No. 3.

"Berichte der Deutschen Chemischen Gessellschaft," Vol. 70, No. 3.

"Russian Journal of General Chemistry," Vol. 6, No. 12; Vol. 7, No. 1.

"Experiment Station Record," Index to Vol. 74, and Vol. 76, No. 2.

"Transactions of the Faraday Society," Vol. 33, Part 3.

"Indian Forester," Vol. 63, No. 3 and Index to Vol. 62.

"Forschungen und Fortschritte," Vol. 30, Nos. 6–8.

"Marriage Hygiene," Vol. 3, No. 3.

"Journal of the Indian Mathematical Society," Vol. 2, No. 5.

"Medico-Surgical Suggestions," Vol. 6, No. 3.

"Review of Applied Micology," Vol. 16, No. 2.

"Journal of the Bombay Natural History Society," Vol. 39, No. 3.

"Nature," Vol. 139, Nos. 3512–17.

"Journal of Nutrition," Vol. 13, Nos. 2–3.

"Indian Journal of Physics," Vol. 20, No. 1.

"Research and Progress," Vol. 3, No. 2.

"Canadian Journal of Research," Vol. 15, Nos. 1 and 2.

"Journal of Research, National Bureau of Standards," Vol. 17, Nos. 3–5.

"Science and Culture," Vol. 2, No. 9.

"The Sky," Vol. 1, No. 5.

"Science Forum," Vol. 2, No. 1.

"Scientific American," Vol. 156, No. 1.

Government of India Publications:—

"Indian Trade Journal," Vol. 133, No. 1603; and Vol. 134, Nos. 1605–1607.

"Bulletin of Industrial Research," No. 6.

ACADEMIES AND SOCIETIES.

Indian Academy of Sciences:

March 1937. SECTION A.—CH. V. JOGARAO: *An Optical Method of Determining the Relative Coagulating Powers of Electrolytes.*—The coagulation of arsenic sulphide sol in the presence of various electrolytes has been studied by measurements of depolarisation of the light scattered by the sol. R. ANANTHAKRISHNAN: *The Raman Spectra of Crystal Powders.—IV.—Some Organic and Inorganic Compounds.* The Raman spectra of a number of organic and inorganic crystal powders have been obtained by employing the technique of complementary filters. Many new frequencies have been recorded. The significance of the results is discussed. S. R. SAVUR: *A New Solution of a Problem in Inverse Probability.*—A new "statistical" solution of the problem in inverse probability referred to by Karl Pearson as "the fundamental problem in practical statistics". R. K. ASUNDI AND R. SAMUEL: *Some Remarks on the Birge-Sponer Method of Vibrational Extrapolation.* R. K. ASUNDI AND R. SAMUEL: *Note on the Structure of* N_2^+ *and its Bearing on the Theory of Valency.* S. RANGASWAMI AND T. R. SESHADRI: *Geometrical Inversion in the Acids Derived from the Coumarins. Part IV. The Behaviour of the Ethers of the* Cis *and* Trans *Acids.* B. L. GULATEE: *Gravity, Geoid and Plumb-Line Deflections in Mountainous Areas.* INDER CHOWLA: *On* $\Gamma(k)$ *in Waring's Problem and Analogous Functions.* S. ZAFARUDDIN AHMED AND R. D. DESAI: *Heterocyclic Compounds. Part I.—Coumarins from Cyclopentanone-2-Carboxylate and 4-Methyl-cyclopentanone-2-Carboxylate.* R. ANANTHAKRISHNAN: *The Raman Spectra of Some Simple Molecules. (Dimethyl Ether, Phosgene,* n-*Butane, Ethylene Diamine, Ethylene Glycol, Ethylene Dichloride, Ethylene Dibromide, Acetylene Tetrachloride, Acetylene Tetrabromide and Hexachloroethane.)*—The Raman spectra of the above substances have been studied and the problem of "free rotation" in ethane derivatives is discussed in the light of these results. C. V. RAJAM: *Microphone Acutated Thyratron Relay.*—Details are given of a thyratron valve amplifier circuit which can be used as a simple sound intensity meter.

March 1937. SECTION B.—A. C. JOSHI AND L. B. KAJALE: *Fertilisation and Seed Development in Amarantaceæ.*—A detailed account of embryogeny for the family Amarartaceæ is given. C. BHASHYAKARLA RAO: *A New Species of* Anabæna (Anabæna ambigua *Sp. Nov.*).—A peculiar blue-green alga collected from a few ponds near the Benares Hindu University grounds, has been completely studied and recorded. The results justify its being considered a new species of *Anabæna.* BENI CHARAN MAHENDRA: *A Note on the Distinctive Characters of the Indian Species of* Cylindrophis *Wagler.* A revised key for the genus *Cylindrophis* Wagler, drawn up by Dr. Malcolm Smith has been presented. JOGENDRA NATH MISRA: *The Zygnemaceæ of Kashmir—I.* The first of the series of papers on the algal flora of Kashmir. 19 forms have been recorded and out of these 4 species, 4 varieties and 6 forms are new.

National Institute of Sciences, India:

March 25, 1937.—The Easter Meeting of the National Institute of Sciences of India was held at Allahabad, PROF. M. N. SAHA presiding.

DR. G. R. TOSNIWAL gave an account of the radio studies of the upper atmosphere which was followed by a theoretical paper by the President and MR. R. N. RAI on the propagation of radio waves from the Ionosphere. DR. S. B. DUTT, Reader in Chemistry in the Allahabad University, and his pupils contributed six papers on the chemical analysis of Indian Medicinal Plants. DR. BHATTACHARYA gave an account of his work on the Zoology of Golgi bodies. PROF. BURRIDGE reported cases of Tuberculosis which he had discovered among frogs at Lucknow and propounded a new theory of colour vision. MR. P. C. GUPTA, a student of Prof. Burridge, reported the results of his experiments on the Sodium Iodo Acetate.

National Academy of Sciences, India:

March 2, 1937.—N. R. DHAR AND E. V. SESHACHARYULU: *Nitrogen Fixation and Azotobacter Count on the Application of Carbohydrates and other Energy Materials to the Soils.* S. K. MUKERJI: *Changes in Soil Nitrogen after the Addition of Fresh Cowdung to Soil.*—Fresh Cowdung has been shown to fix atmospheric nitrogen. Molasses accelerate the oxidation of cowdung in soil and increses the total amount of nitrogen fixed. S. PRADHAN: *The Alimentary Canal of Coccinella Septumpunctata.*—The excretory Malpighian tubules reassociated with the high gut in the lady-bird beetle, act as a filter for eliminating waste nitrogenous material contained in the liquid which is mechanically pressed out of the hind-gut into body-cavity. BIRBAL SAHNI AND K. P. RODE: *Fossil Plants from the Deccan Intertrappean Beds at Mohgaon Kalan (C. P.), with a Note on the Geological Position of the Plant-bearing Beds.*—The affinities of the fossil flora of the Deccan Intertrappean Beds strongly support the view, recently revived by Professor Sahni, that the earliest volcanic lavas (traps) of the Deccan were poured out in the Eocene period, that is, soon after the dawn of the Tertiary era. This view was held by the pioneer geologists a hundred years ago, but during the last seventy years, as the result of work done by the Geological Survey of India, the opinion has grown that the earliest traps were older, and of Cretaceous age. This official view of the Survey, although based only upon indirect evidence, has been accepted by geologists, all over the world; but it is opposed to the direct evidence of the fossil plants which have decided Tertiary affinities.

In the first part of this paper PROFESSOR SAHNI shows that the fossil flora of Mohgaon Kalan near Chindwara, originally discovered by Mr. Rode, has Tertiary affinities, like the flora of the rest of the Deccan Intertrappean series. In the second part Mr. Rode describes the geology of the area and shows that the fossiliferous beds really belong to the basal part of the series. This latter fact is important, because if the basal trees of the series is of Tertiary age, then ther ures. In

no ground whatever for classifying the higher strata as Cretaceous.

The value of fossil plants as an index of geological age is now being increasingly recognised in India, where the ages of some of the most important rock systems, containing coal, oil, salt and other mineral products, have been elucidated by a study of their plant fossils.

The Indian Mathematical Society:

(*Journal*, 2, *No.* 4.)

V. GANAPATHY IYER: *On Integral Functions of Finite Order and Minimal Type.*—Let $[z_n]$ be a sequence of distinct complex numbers tending to infinity and arranged according to non-decreasing moduli. Let $\sigma(z)$ be the canonical product with simple zeros at z_n. The index of distribution (I.D.) of $[z_n]$ is defined as the greatest lower bound of numbers h such that

$$\Sigma\left|\frac{1}{\sigma'(z_n)z_n{}^{h+1}}\right|$$

converges. In previous papers, the author has discussed the properties of integral functions bounded at a sequance of points with finite (*i.e.*, not $+\infty$) I.D. The object of the present paper is to discuss certain cases where the I.D. may be infinite while the value of the function at $[z_n]$ is subjected to more stringent hypothesis than mere boundedness. (2) D. D. KOSAMBI: *Differential Geometry of the Laplace Equation.*—Given a linear partial differential equation $a^{ij}u_{,i,j} + b^iu_{,i} = 0$, the necessary and sufficient conditions are worked out that it should be the Laplace equation associated with some Riemann space. R. VAIDYANATHASWAMY: *A Note on the Morley-Peterson Theorem.*—In this note, the real significance of the well-known Peterson-Morely theorem about a skew hexagon is brought to light, thereby affording not merely a new proof of the theorem, but also its generalisation. S. MINAKSHI-SUNDARAM: *Tauberian Theorems on Dirichlet's Series.*—Two results due respectively to K. Ananda Rao (*Proc. L.M.S.* (2) 34: Theorem 4) and V. Ganapathy Iyer (*Annals of Math.*, 36, Theorem 4) are generalised. Some remarks are made about the application of these theorems to obtain certain precise results, anticipated by Ananda Rao, on the abscissæ of summability of Dirichlet's series. K. RANGASWAMI: *On the Pedal Quartics of a Quadric.*—A paper in continuation of his paper on the Theory of Normals to a quadric in the *Proc. Ind. Ass. Sc.*, 1. R. C. BOSE: *Analogue of a Theorem of Blaschke.*—Let $r = r\,(s)$ be the vector equation of a plane curve V, s denoting the affine length. Let $r_1 = r'(s)$, $r_2 = r''(s)$ be the vector equations of the tangent and curvature forms V′, V″. Let ρ be the radius of curvature at any point of V, and r_1, r_2 the lengths of the radii vectors to the corresponding points on V′ and V″, and p_1, p_2 the lengths of perpendiculars from the origin to the tangents at these points. Then it is proved that $r_2 = l^{-\frac{1}{3}}$; $p_1 = l^{\frac{1}{3}}$ where l is the semi-latus rectum of the osculating parabola to V. It is also proved that "on an elliptic convex oval we can find at least three pairs of points, such that the latera recta of the osculating parabolas are equal, and the affine normals are parallel". N. G. SHABDE: The object of this paper is to collect a number of results involving the confluent hypergeometric functions such as the K-functions, D_n functions, Laguerre functions and Bessel functions, some of the results being obtained by operational methods.

Indian Chemical Society:

December 13, 1936.—BALWANT SINGH AND IJAZ ILAHI: *PotentioMetric Studies in Oxidation Reduction Reaction. Part I. Oxidation with Potassium Iodate.* HARENDRA KUMAR ACHARYA: *Properties of Activated Sugar Charcoal Coated with Various Substances. Part I. Liberation of Acid and Alkali by the Action of Neutral Salts in Relation to the Surface Charge.* R. D. DESAI AND M. A. WALI: *Dihydroresorcinols. Part IV. The Condensation of Phenyl dihydroresorcinol with the Aromatic Aldehyde.* MAHENDRANATH RUDRA: *Studies in Vitamin C, Part II. The Vitamin C Contents of the Liver and Muscle of Some Indian Freshwater Fish.* MAHAN SINGH AND MANOHAR SINGH: *Studies on Optical Activity and Chemical Constitution. Part III. Optically Active Acids and Bases.* K. M. SIL, G. C. ROY AND P. N. DAS-GUPTA: *A New Method for the Separation of Lead from Copper and their Subsequent Estimations.* D. N. CHATTERJI, K. R. GANGULY AND M. Z. FARUQI: *Estimation of Small Quantities of Arsenic in Medicolegal Cases.* SHRIDHAR SARVOTTAM JOSHI AND N. HANUMANTHA RAO: *Studies in the Coagulation of Colloids. Part XV. New Aspects of Gold Sol Coagulation.*

January 1937.—SIR UPENDRANATH BRAHMACHARI: *Certain Aspects of the Chemotherapy of Synthetic Hypnotics.* K. N. GAIND: *Synthesis of New Local Anæsthetics. Part I.* SUDHAMOY MUKHERJEE: *The Electrochemical Properties of Palmitic Acid Hydrosols.* DUHKHAHARAN CHAKRAVARTI AND BHOWNI CHARAN BANERJEE: *On the Constitution of Nitro-β-Methylumbeliferone Methyl Ether and of Chlororesorcin.* P. R. KRISHNA SWAMY AND B. L. MANJUNATH: *Chemical Examination of the Roots of* Aristolochia Indica, *Linn.—Part III.* Isolation of the Alkaloid Aristolochine. GOPAL LAL MAHESWARI AND J. B. JHA: *Potentiometric Estimation of Lead with Sulphide Solutions.* M. B. RANE AND K. KONDIAH: *A Method of Qualitative Analysis without the Use of Hydrogen Sulphide.* HIRENDRA NATH BANERJEE: *Chemical Examination of* Clerodendron Infortunatum—*Part I.* K. P. DAVE AND K. S. NARGUND: *A Note on the Preparation of β-4-Methoxy-1-napthoylpropionic Acid.*

Indian Botanical Society:

March 1937.—F. BOERGESEN: *Contributions to a South Indian Marine Algal Flora.* I. K. BISWAS: *Two New Flowering Plants.* B. N. SINGH AND R. B. SINGH: *The Role of Leaf Water-content, Soil Moisture and Plant age on Transpiration of Crop Plants.* B. N. SINGH AND S. C. CHAKRAVARTI: *Unequal Absorption of Ions and Their Rate and Order of Entry from a 3-Salt nutrient.* V. VENKATESWARALU: *A Note on the Development of the Embryo-sac in* Phrynium capitatum.

G. V. KRISHNA IYENGAR: *Development of Embryo-sac and Endosperm-Haustoria in Some Members of the Scrophularineæ.—Part I.*—An account of *Sopubia delphinifolia* G. Don. and *Alonsoa* sp.
M. O. P. IYENGAR: *Fertilization in* Eudorina elegans *Ehrb.*

Meteorological Office Colloquium:

February 9, 1937.—MR. S. BASU of the Indian Meteorological Survey, on his return from the meetings of the Regional Meteorological Commission for the Extreme Orient held at Hongkong in January 1937, gave an account of the work done at the meetings of the Commission.

February 16 and 18, 1937.—The Colloquium was addressed by LT.-COL. E. GOLD, D.S.O., F.R.S., (of the London Meteorological Office, and President of the International Commission for Synoptic Weather Information), who visited India on his way back to London from the Hongkong Conference. In his first address, he gave a thrilling and valuable account of his recollections of meteorological work in France during the years of the Great War while for the theme of his second address he chose " Weather Forecasting ".

March 2, 1937.—DR. S. N. SEN: *Long-range Forecasting of the Monsoon with Special Reference to the Everest Expeditions.*

March 16, 1937.—DR. C. W. B. NORMAND: *Criteria of Stability of Particles and Layers of Air in the Atmosphere.*

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Bombay University:

Royal Institute of Science, Bombay.—Prof. G. R. Paranjpe, Head of the Physics Department, has been granted leave from 20th June to 9th October 1937.

Dr. N. R. Tawde, Lecturer in the Physics Dept., will act as Professor of Physics during the absence of Prof. Paranjpe on leave.

Dr. T. S. Wheeler has been granted the Honorary Degree of M.Sc. by the National University of Ireland.

Under the University Bifurcation of Arts and Science courses, the Institute will discontinue teaching upto Intermediate standard from June 1937. These classes will be transferred to the Elphinstone College.

University of Mysore:

1. *Personnel.*—Dr. E. P. Metcalfe, D.Sc., Vice-Chancellor, has, in continuation of the long vacation from the 1st April 1937, been granted leave preparatory to retirement from service. Mr. N. S. Subba Rao, M.A., Bar-at-Law, Director of Public Instruction in Mysore, has been appointed to be in charge of the duties of the Vice-Chancellor in addition to his own during the above period or until further orders.

Mr. A. B. Mackintosh, M.A., Professor of English, Maharaja's College, Mysore, has been granted five months' combined leave from the 24th June 1937, in continuation of the long vacation.

2. *Senate.*—The annual meeting of the Senate was held on the 22nd March 1937. Among the propositions that were passed, mention may be made of the following :—

(i) Introduction of an ordinance regulating the course of study in German for B.Sc. Honours students.
(ii) Institution of a separate minima for the papers, thesis and *viva voce* for the Master's Degree examination.
(iii) Revised syllabus in Mathematics for the Intermediate, B.A., and B.Sc. Degree examinations.
(iv) Provision for the admission of L.M.P. diploma holders to the M.B.B.S. degree course, under certain conditions.

558-37.—Printed at The Bangalore Press, Bangalore City, by G. Srinivasa Rao, Superintendent, and Published by B. N. Sastri, M.Sc., A.I.C., A.I.I.Sc., for the " Current Science " Board of Editors, Indian Institute of Science, Hebbal Post, Bangalore.

CURRENT SCIENCE

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CONTENTS.

Indian Fisheries and Japanese Enterprise.

THE *Statesman* of Calcutta in its issue of the 17th February 1936, published the following news from its Singapore correspondent under the heading "Fish in Abundance: Japanese Boats operating in Indian Ocean":—

"Japanese trawlers are catching large quantities of fish in the Indian Ocean between Penang and Calcutta and are transhipping it at Singapore for transport to Japan. Previously the trawlers had been operating in the China Sea and off Australia, but their catches decreased owing to the operations of other trawlers in the same waters.

"In the Indian Ocean the Japanese ships, it is stated, are finding an abundance of fish and as much as 80 to 100 tons of fish are transhipped at Singapore for Japan. Most of this is for consumption there but a quantity is shipped back to Singapore as fish meal."

This news does not seem to have caused any stir at the time, but recently when the *Statesman* in its issue of the 5th March 1937 reported the appearance of a Japanese trawler, the '*Shinkyo Maru*,' in the Kidderpore Docks, Calcutta, with a cargo of about 200 tons of fish, "including pomfret, bekti and lobsters caught in the Bay of Bengal," considerable interest was aroused, both in the press and the public, regarding the fisheries of the Bay of Bengal and the paucity of the supply of fish to Calcutta. Though at the time great difficulty was encountered in investigating the significance of this new move on the part of the Japanese vessel, three days later the *Statesman* published a short note on Calcutta's Fish Supply and reported the Japanese plans of working 40 trawlers for the new enterprise. It stated that

"The presence in the port of Calcutta of the Japanese trawler *Shinkyo Maru*, laden with fish from the Bay of Bengal, initiates an experiment made by a long-established business house in Japan.

"One of the fleet of 40 vessels constructed for the purpose, the *Shinkyo Maru* has a capacity for carrying about 500 tons of fish. Its equipment, like that of its sister ships, is most

modern in every respect. Other vessels of the fleet serve Rangoon, Singapore and other Far Eastern Ports.

" It was explained to a *Statesman* representative that this was a well prepared and serious attempt to supply Calcutta with fish, and that interested enquiries from many consumers had already been received.

" Upon the success of the experiment depends the continuation of supplies from this source.

" It has been estimated that in Bengal 80 per cent. of the population consume fish as a regular item of diet when they can afford to buy it; yet so badly is the industry organized and so hopelessly are the actual fishermen in the hands of *mahajans* and middlemen that an ever-increasing demand goes unsatisfied while the price of such supplies as reach the Calcutta markets is maintained at a level which can only be described as exhorbitant.

" The possibilities of establishing remunerative steam trawling in the Bay of Bengal have never been sufficiently explored, even though investigation had proved that there are extensive areas in the Bay capable of yielding large quantities of high-class fish and which are suitable for trawling.

" An experiment that was made was a financial failure mainly because of the hostility of vested interests, and the lack of cold storage facilities. The latter difficulty no longer exists.

" Calcutta consumes about 700–800 maunds of fish daily, but the supply is regarded by dealers as insufficient. In the last decade the demand has increased 40 per cent. but the supply only 25 per cent.

" If the new Japanese enterprise can regularly contribute to the deficiency, and at the same time exert an influence in the way of forcing prices down the visit of the *Shinkyo Maru* may prove economically important."

We have quoted the report of the *Statesman* in full, as it sums up admirably the present position of the fish supply of Calcutta and the necessity for augmenting it from the Bay of Bengal, an immense source of supply near at hand. The public reaction to these statements has been of two opposing types. Some have agreed with the *Statesman* and look upon the Japanese enterprise as a great boon to the poor people whose unbalanced diet is in reality the cause of so much sickness and ill-health in this country and to which the Government has become greatly alive during the last 2 to 3 years. While there are others who consider that the Japanese enterprise will adversely affect a large number of persons engaged in fish trade and that a very big industry, almost next to agriculture in its potentialities, will pass into the hands of the Japanese and it may become politically difficult afterwards to turn them out. Both these views deserve the greatest consideration before any action should be taken in the matter.

There appears to be a general agreement that the Bay of Bengal is teeming with fish life and that all grades of economic fish, from Cat fishes to Pomfrets and Perches, are found in plenty in this area. Two of the Surgeon Naturalists on board the s.s. '*Investigator*,' the late Lt.-Col. A. Alcock and Lt.-Col. R. B. S. Sewell, who had opportunities to do extensive trawling in the Bay have forcefully expressed their views that the fisheries of this area are very rich. The officers of the Government of Bengal, Sir K. G. Gupta, Mr. A. Ahmad, Dr. J. T. Jenkins, Mr. T. Southwell and Dr. B. Prashad, who were appointed from time to time to report on and investigate the possibilities of fisheries, both fresh-water and marine, also came to the conclusion that the Bay of Bengal is almost a limitless source of marine fisheries. A careful study and analysis of the reports of the Government of Bengal's Steam Trawler '*Golden Crown*' also shows that there are many rich fishing grounds in the Bay and, provided a suitable organisation can be set up, there are great possibilities for the development of the Bay fisheries.

The next consideration in such an undertaking would be the disposal of the catches, and here again opinion is unanimous that there is a great demand in Bengal for fish, as almost 80 per cent. of the population would eat fish as a regular item of diet if they could afford to buy it. As the dietetic researches advance there is no doubt that the percentage of the fish-eating population will also increase. As has been stated in the *Statesman's* report quoted above, the demand for fish has already increased during the last decade by 40 per cent. but the supply by only 25 per cent.

It is stated that Bengalis, as a class, are fond of fresh-water fish, mostly carps and a few types of cat fishes, and that there is little demand in the Province for marine fish. In the present circumstances there would seem some justification for this view, because a very small quantity of marine fish is exhibited for sale in Calcutta markets, and even this quantity, which is sold at higher rates than the local fresh-water fish, is brought down for consumption by the foreigners, Europeans and others, in this

cosmopolitan town, from Puri and Balasore by train. Those, who have had opportunities to go round the Calcutta fish markets, are greatly struck by the paucity of the commodity, the average high price of fish of all kinds and the absence for sale of any truly marine forms. The quantity of fish brought to the markets is so small that practically the whole of it is sold out within a couple of hours, and the business is so remunerative that the traders make enough money within this short period. Even if it be admitted that the Bengalis have an inherent prejudice against marine fish, it should be borne in mind that propaganda and education are two very potent agents in overcoming such prejudices. Above all, the necessity of fish diet for a rice-eating population is so great that a simple knowledge of the dietetic value of fish will appease this prejudice. It should also be remembered that whereas the rich may still continue to eat only carps; the poor will readily take to cheaper fish provided it is made available to them. Moreover, the influx of cheaper marine fish will no doubt bring down the prices of other types of fish in the market.

As an instance of what sound commercial propaganda can do, one may cite the instance of "Wolf-fish", a Blennid, of the British coasts. It is so horrid-looking that people detest to buy it, in spite of the fact that its flesh is nice and tasty. Researches have shown that its flesh possesses great nutritive value. To remove the public prejudice against the fish, the traders have given it a sweet commercial name and they never exhibit it for sale with the head intact. Only properly cleaned flesh is sold and very few people, who relish it, know that they are consuming "Wolf-fish".

As an outstanding case of supply and demand one may give another instance of the sale of cartilagenous fishes—Skates and Rays—in Great Britain. Before the War, this type of fish was not much in demand, but during the War when fishing outside the territorial waters became dangerous, the consumption of this type of fish increased. Investigations into the nutritive value of these fishes showed that they were considerably superior to a large number of popular fishes. Thus the fishery of the cartilagenous fishes has come to stay and there is hardly any prejudice against their consumption now,

These instances, which can be multiplied, show what can be achieved by proper organisation and application of science to everyday needs of life. There need not be any diffidence, therefore, regarding the ultimate success of the Bay fisheries. What is needed is the harnessing of financial resources, energy and ability. Above all, the application of science to methods of trade should not be lost sight of.

From the above it is clear that there is a great demand for fish in Bengal generally, and in Calcutta particularly. It is also clear that there is an immense source of supply near at hand. To a layman it would appear a very simple proposition of economics to correlate these two factors. Attempts, unfortunately not fully organised, have been made in the past to fish in the Bay and to supply the ever-growing demand of the Calcutta fish market. But the hostility of the vested interest has been so great that it has been difficult for small enterprises to fight it. It is most essential, that a powerful organisation with considerable financial resources should be set up. The past failures are a great deterrent to the public zeal and, therefore, it would seem to be the duty of the Government of Bengal or of the Corporation of Calcutta to lead the way. A small beginning on the lines of the Bombay Government should be made, small steam trawlers equipped with modern appliances should be purchased, and fast transport of catches from the sea to the cold storage at Calcutta should be organised. When the experiment is carried on for sometime, the public will see the utility of the scheme, and then Government can sell these trawlers and launches to private concerns. Within a very short period under the guidance of a fully trained Indian scientist, such a scheme has achieved a lot and the Fisheries Department of the Province has been greatly expanded. In such enterprises local knowledge is a great asset and, therefore, the failure of some of the earliest schemes of the various Governments can be partly attributed to their importing Europeans for fisheries work.

Now supposing for a moment that the Government of Bengal is not willing to undertake this work and there is no other agency in this country that is likely to work the fisheries of the Bay, is it not desirable to seek the help of foreigners in

this matter? In this connection, it should be remembered that by the International Laws exploitation of the sea products is open to all nationals outside the territorial limits. No one can, therefore, question the rights of the Japanese to fish in the Indian Ocean outside the territorial waters, and if they are prevented from coming to Calcutta they would seek other ports to dispose of their catches. Any interference on the part of the Calcutta citizens with the Japanese enterprise would, under the circumstances, seem like the policy of the dog in the manger. Commenting on "Japan and Bengal Fisheries", the *Statesman* in its editorial of the 15th April 1937 concluded that "Japanese fishermen might be excluded from fishing in territorial waters they can hardly be altogether kept out of the Bay of Bengal. In any event what is good and acceptable for Rangoon and Singapore cannot be altogether bad for Calcutta." This is very sound advice indeed. Those, who have the good of the poor at heart and the interest of the starving millions of Indians, should lose no time in organising the fisheries of the country and place a highly nutritive source of food within the reach of all. If we are not capable of managing it, let outsiders show us the way. An arrangement can be made with an outside agency that after a number of years the terms of agreement will be revised. The sea provides a harvest which requires no sowing. What is needed is its exploitation on proper scientific lines. In our editorial on the Marine Fisheries of India (October 1933) we indicated the lines along which the work should be organised and suggested the creation of a Central Bureau of Fisheries for scientific enquiries and investigations. When early in September 1934, the Advisory Board of the Imperial Council of Agricultural Research held a prolonged discussion on the condition of the Fisheries industry and the possibility of its development, it was expected that the Fisheries Committee to be appointed by them would be able to investigate the question in all its aspects, but unfortunately nothing has so far come out of this talk. It seems to us a most opportune moment to refer to the findings of the Royal Commission on Agriculture on "Fish as an article of diet", because we feel that during the Viceroyalty of Lord Linlithgow, who was the Chairman of the Royal Commission, the fishery problem of India will receive due consideration. It is stated in the report that

"We have been struck with the comparative failure to develop the fisheries of the country as a source of food. We are aware that, in certain parts of the country, there are religious objections to the use of fish as an article of diet. But in Madras and Bengal, it is readily taken and much relished by some four-fifths of the total population. In Burma, it is universally liked and in the form of a fish paste (ngapi) is regarded as an indispensable condiment. In Bombay, the United Provinces and Bihar and Orissa, large classes of the population take it when they can get it and, in the Punjab, there has been, since the War, a largely increased demand for it. Fish forms a specially valuable addition to a diet the staple of which is rice.

"We note with regret that the Fishery Department in Bengal was abolished as a measure of economy in 1923. We understand that the Government of Bengal are desirous of reconstituting it for work on inland fisheries only, as soon as their finances permit. We consider that the development of inland fisheries in Bengal should be regarded as one of the most urgent measures of rural amelioration and we recommend that, if the financial situation does not permit at present of the reconstitution of the department, at least one officer possessed of the necessary qualifications should be placed on special duty to promote interest among local authorities in the stocking of tanks with suitable fish and their conservation. The existing fishery departments in the Punjab, Bihar and Orissa and Madras should be strengthened for the same purpose. A special officer has been recently appointed in Burma with a view to submitting proposals for increasing the efficiency of the inland fisheries. We suggest that his investigations should include an examination of the case for entrusting the development of these fisheries to a properly organised department. We recognise that a certain amount of work is already being done in some provinces in regard to the conservation of the existing stocks of fish. Ladders are being constructed over weirs at the head-works of canals, regulations prohibit the capture of fish by dynamiting, poisoning and the use of small meshed nets, and rewards are being given for the destruction of various enemies to edible fish. Propaganda is also being undertaken to enlist the sympathies of the professional fishermen in the working of such beneficial regulations. There is clearly, however, room for further development in conservancy work along these lines in all provinces.

"Generally, we note that it has been the policy of local governments to insist upon the Fishery Department paying its own way and that, in consequence, the staff has been restricted to a few members. We regard this as a mistake and recommend that a longer view should be taken of the possibilities of development of the fish resources of the country in the interests of the people as a whole. The chief object of the department should not be revenue but public benefit.

"We are fully aware that, if material progress is to be made in augmenting in this way the food supply of rural areas, it will be essential for the district boards, and the rural community generally, to play their part in the stocking of local waters and in their conservancy. It will be for the public health officers and for all organisations interested in the welfare of the people to disseminate a knowledge of the value of the addition of fish to diet. But without some expert authority at provincial headquarters, there will be a risk that ill-advised experiments in stocking may be made and the resultant failures will seriously endanger the prospect of success for the movement as a whole.

"Improvement in the cultivator's diet holds out such promise of improvement in his general health and the addition of fish to his diet impresses us as being so much the most promising way of providing it over large areas of the country, that we consider that we are more than justified in making recommendations which, to those who know the difficulties, may well appear to err somewhat on the side of optimism."

In our opinion the time has come when the Central Government, Governments of the various autonomous provinces, local bodies and the public at large can no longer ignore the development of Indian fisheries, and if there is *no* enthusiasm for such an enterprise in this country we should not stand in the way of the Japanese who would help the masses of India by exploiting the fisheries resources of the Bay.

The Vitamin B_2 Complex and Allied Factors.

I. Mammalian Factors.

By J. R. O'Brien and R. A. Peters.

(*Department of Biochemistry, Oxford.*)

THOUGH many suspected that vitamin B was multiple in nature, convincing proof that this was so was not produced until 1926 when, mainly by the method of feeding supplementary foodstuffs, several workers established that at least two factors were involved in rat nutrition. Of recent times this fact has induced an extensive investigation of the water-soluble factors required not only by the rat but also by the pigeon, chick, etc. It has led to the accumulation of considerable evidence for the existence of several factors generally classified under the heading of vitamin B of which an individual animal may require at least two. Table I is a list of the different factors of the vitamin B group for which evidence has been offered:

TABLE I.

Vitamin B factors (other than vitamin B_1) so far shown to be essential for mammalian nutrition.

Rat ..	vitamin B_2 ..	flavin vitamin B_6—antidermatitic
	vitamin B_4 ..	(position uncertain)
Dog ..	Black tongue factor	
Man ..	Anti-pellagra factor vitamin B_6	(P-P factor of Goldberger)

At present it is important to differentiate the several factors of the rat, pigeon, chick, dog and man because a superficial similarity in chemical and physiological properties suggests but does not prove a relationship among them. Of one factor only, namely flavin, is it possible to speak with some certainty. This has been isolated in crystalline form from natural sources, particularly vitamin B_2 extracts, and its structure established by synthesis. Its physiological properties have been studied in greatest detail in the rat.

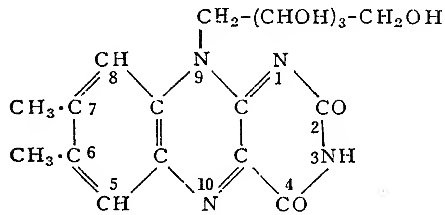
LACTOFLAVIN.[1]

(Ovoflavin from eggs,[2,3] hepatoflavin[4] from liver, and renoflavin[5] from kidney.)

For over 80 years we have been aware of the presence of substances in animal tissues fluorescing in ultraviolet light. Many tissues contain substances fluorescing blue like quinine; Bence-Jones (1866)[6] called this property quinoidine. A preliminary investigation by Kinnersley, Peters and Squires (1925)[7] indicated that the blue fluorescence of tissues was due to more than one quinochrome (*i.e.*, substances fluorescing blue) and that those in yeast accompanied but were not identical with vitamin B_1. In 1933 a new class of natural pigments with a yellow-green fluorescence came into prominence. The biological significance

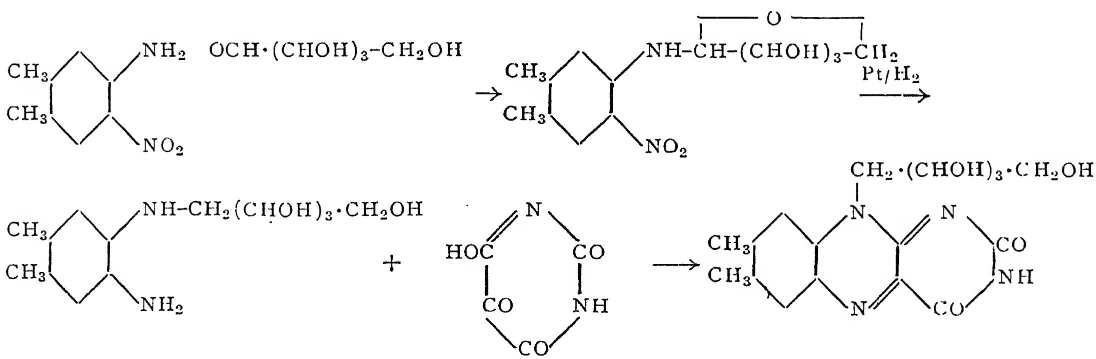
of these compounds, called flavins, was realised from the earlier isolation from yeast of an iron-free enzyme consisting of a yellow-green fluorescent component united with a protein. [Warburg and Christian (1932)[8].] Separation of the fluorescent prosthetic group, easily effected by hydrolysis, yielded an orange crystalline substance of composition $C_{17}H_{20}N_4O_6$. Meanwhile a detailed examination of the yellow-green fluorescing substances in tissues by Ellinger and Koschara[9] and Kuhn and his coworkers[10] showed that Warburg's substance was a member of a class of compounds, the lyochromes. Further emphasis on the importance of these substances was given by the report of Kuhn, György and Wagner-Jauregg[10] who, working on the nature of vitamin B_2, isolated a crystalline substance which proved to be identical in composition with the flavin of Warburg and promoted the growth of rats adequately provided with other components of the vitamin B complex. The discovery stimulated investigation into the chemistry of these compounds—some hundred or more papers being published quickly by several laboratories culminating in the synthesis of the natural product and a few of its homologues, by Karrer and Kuhn.

The steps leading to the elucidation of the structure of flavin were briefly as follows:—Warburg and Christian (1932)[8] had already shown that irradiation of flavin in alkaline solution caused its destruction with the loss of four carbon atoms and the production of lumiflavin. Upon alkaline hydrolysis lumiflavin decomposed yielding a molecule of urea. Detailed examination of the degradation products by Kuhn, Rudy and Wagner-Jauregg[11] showed that the loss of 4 carbon atoms upon irradiation arose from the breakdown of a pentose chain, confirmed the loss of urea from lumiflavin by hydrolysis and found that the acid formed simultaneously had a molecular composition suggesting a quinoxaline structure. It was therefore presumed that flavin was a dimethyl isoalloxazine containing a pentose group in the 9 position. This view was supported by evidence from a spectrographic examination of a series of alloxazine derivatives by Stern and Holiday.[12] The synthesis of flavin rapidly followed. Several homologues of the natural substance were prepared before lactoflavin itself was actually obtained. From a comparison of the biological and chemical properties of the synthetic compounds and of natural flavin the structure assigned to flavin was 6·7-dimethyl-(d-1′-ribityl)-isoalloxazine.



Flavin

The type of synthesis may be illustrated by the following series of reaction :[13]

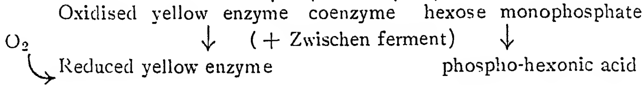


Other methods of synthesis are : Condensation of pentose with the N-mono-acyl or preferably carbethoxy-amino derivatives of dimethyl phenylene diamines.[14] After reduction with nickel and hydrogen in an autoclave, the condensation product is allowed to combine with alloxan when flavin is formed. The synthesis is achieved by Kuhn and Weygand[15] by condensing amino pentose with o-chlor nitro xylene. The labile N substituted diamine is reduced in the presence of alloxan by stannous chloride. After removal of the excess of

reducing agent the leucoflavin is oxidised by shaking with air.

The flavins are orange-yellow crystalline solids soluble in water, slightly soluble in alcohol but otherwise insoluble in organic solvents. Their characteristic feature is a yellow-green fluorescence accompanied by marked sensitivity to light.[8,10,16,17-22] According to the experimental conditions two main products arise from the irradiation of flavin solutions: (*a*) in alkaline medium, lumiflavin (6·7-dimethyl-9-methyl-isoalloxazine) and (*b*) in neutral solution, lumichrome (6·7-dimethyl-alloxazine), an intensely blue fluorescent compound.[19] Another interesting property is the reversible oxidation reduction of flavin. On treatment with hydrosulphite flavin is reduced to a colourless leuco form which is reconverted to the original yellow-green form on shaking with air. The smoothness and the ease with which these reactions proceed suggests a relation with the physiological function of flavin.

A further clue to the physiological rôle of flavin is given by the mode of combination in which it exists in various animal plant tissues. In yeast and in such organs as liver, heart, kidney, flavin exists in two forms: free flavin and flavin in a non-dialysable form. Warburg has shown that his yellow enzyme is a protein carrying flavin as a prosthetic group. More recently, Theorell[23] has found that the flavin in the yellow enzyme is actually present in the esterified form of a phosphate. Treatment of the enzyme with acid leads to a decomposition into flavin phosphate and protein. In neutral solution both these fragments recombine to give a product possessing the same activity as the original enzyme. The action of the yellow ferment has been studied by Warburg particularly with hexose monophosphate (Robison ester) as substrate. In the oxidation of hexose monophosphate to phospho-hexonic acid, flavin apparently functions as a vehicle for oxygen transportation:



A deficiency of flavin in the diet manifests itself most definitely in the rat although evidence has been presented that this substance is required by other mammals. In the rat it is now generally agreed that flavin deficiency results in a loss of appetite and cessation of growth accompanied after some weeks by the appearance of scurf-like symptoms in the vicinity of the eyes and mouth which are different from the dermatitis usually associated with lack of vitamin B_2. The hair is shed with the development of bald patches over the head and face but no swelling or inflammation of the paws occurs (Copping, 1936).[24] The daily administration of 15γ of flavin promotes growth and restores the hair. The flavin is given in the free form; apparently the rat is capable of converting it into flavin phosphate. In fact some evidence has been presented showing that this may take place in the intestines (Verzàr, 1936).[25] It may be presumed provisionally that the necessity for flavin in the diet is to maintain the supplies of the yellow enzyme. But it is still possible that it has a function in the free state as there are suggestions in the literature that it can act as a catalyst in relation to certain dehydrogenase systems: the matter requires further investigation. It is to be noted that overdosage of some compounds allied to the flavins may result in the appearance of toxic symptoms, for Kuhn and Boulanger (1936)[26] found that with rats isoalloxazines, particularly the 9 phenyl derivative, were toxic.

Vitamin B_6.

The isolation of crystalline flavin from vitamin B_2 concentrates elucidated to some extent the conflicting results of different workers obtained in the study of the antidermatitis factor and raised the question of its possible multiple character. For, in 1930 Chick and Copping[27] and Roscoe[28] published data suggesting that the nature of vitamin B_2 was probably more complicated than previously supposed. These workers presented evidence for the existence of a factor, termed by them "Factor Y" of a stability to heat and alkali greater than vitamin B_2. The importance of this observation was more fully recognised when Kuhn, György and Wagner-Jauregg[10] found that flavin alone was incapable of

curing rat dermatitis and promoting growth. The missing essential constituent could be provided by the addition to the diet of an acid charcoal adsorbate of yeast, a source of vitamin B_4. The heat stability and curative action towards rat pellagra led György to call the missing factor, vitamin B_6.[29] Chick and her colleagues[30] and György[29] are now agreed that vitamin B_6 and factor Y are identical and together with flavin constitute what was previously known as vitamin B_2. It is important to remember that at present the term vitamin B_6 connotes an impure concentrate which may contain other additional factors.

The effect of a deficiency of vitamin B_6 has been amply demonstrated by feeding rats on synthetic diets supplemented with vitamin B_1 and flavin in their pure crystalline forms. From such experiments it has been found that typical rat dermatitis, previously attributed to lack of vitamin B_2 occurs only when the fraction of the vitamin B_2 complex termed vitamin B_6 is absent from the diet. The deficiency creates skin lesions of florid nature and of symmetrical distribution. Initially they manifest themselves by a soreness at the nose, eyes and ears and a redness and swelling of the feet. With time they accentuate : the pinnæ are thickened and encrusted ; there is a marked œdematous appearance of the mouth and the paws ; the latter are usually scabby. Simultaneously these symptoms are accompanied by gastro-intestinal disturbances.* The urine may be reduced in volume and be highly pigmented containing porphyrin. Such symptoms are rapidly alleviated by the administration of Peters' eluate, the decomposed lead precipitate from yeast extracts or by liver extracts.[31]

From time to time attempts have been made to correlate the symptoms of vitamin B_2 deficiency with lesions other than dermatitis. It has been proposed to term vitamin B_6 the rat acrodynia factor[32] on the basis of a similarity of the dermatitis observed in rats to the condition of the hands, etc., seen in children suffering from Pink disease. Such a superficial resemblance may be visualised but neglects the other aspects of the clinical picture of Pink disease. In the opinion of one of the authors, the symptoms do not resemble in detail Pink disease in children.† It has also been suggested that vitamin B_2 evokes cataract in rats.[33,34] At present in view of the conflicting evidence which may be in part due to the use of different diets, it is impossible to reach a definite conclusion. In our laboratory no instances of cataract have so far been observed in young rats on a diet deficient only in vitamin B_6.

In Table II is summarised the distribution of flavin and vitamin B_6 :

TABLE II.

Distribution of flavin and vitamin B_6.[1,2,5,29,31,50,51]

Source	Flavin	Vitamin B_6
Yeast ..	+ + +	+ + +
Liver ..	+ + +	+ + +
Fish muscle ..	small amount	+ + +
Egg white ..	+ + +	small amount
Kidney ..	+ + +	?
Milk ..	+ + +	+ + +
Muscle ..	+	
Suprarenals ..	+	
Corpus Luteum ..	+	
Brain ..	+	
Retina of eye ..	+	

It will be observed that whereas flavin and vitamin B_6 are somewhat equally distributed in liver and yeast, they are unequally so in the egg white, fish muscle and other tissues. White of egg contains mainly ovoflavin with little vitamin B_6 a fact which accounts for the early observation of Chick on egg white as a source of vitamin B_2.

Of the chemical nature of vitamin B_6 little is known. It is not precipitated by the salts of Pb, Hg or Ag ; it is precipitated by phosphotungstic acid, is adsorbed on Fullers' earth at acid pH, inactivated by benzoylation, untouched by nitrous acid, migrates towards the cathode on electrodialysis. It may be a basic substance containing an OH group.[35]

VITAMIN B_4.

This factor is now not so well defined an entity as the original methods of testing

* This is suggested by the occurrence of diarrhœa and abnormal appearance of the gut on post-mortem examination.

† The symptoms resulting from a deficiency of Reader's vitamin B_4 did resemble Pink disease, but see below.

for it have broken down. Originally Reader (1929)[35] described a third rat factor under the name of vitamin B_4 which promoted the growth of young rats on a diet supplemented by autoclaved marmite (vitamin B_2) and a preparation of vitamin B_1 free from vitamin B_4.‡ Later owing to the difficulties of test, the development of a method using adult rats was undertaken. On the same diet the rats showed peculiar symptoms of redness and swelling of the paws together with ataxia. Endeavours to substantiate these findings have failed, the red swollen paws being observed in only 1-2 per cent. of the experimental animals. Ataxic symptoms when present could be cured by the administration of 3-5 units of vitamin B_1 in the form of a crude concentrate or pure crystalline form.[37] The conflicting results may be explained in the future when we possess a pure preparation of vitamin B_6. The difficulty of producing vitamin B_4 deficiency in the rat has been indicated by Kline, Elvehjem and Hart[38] who consider that careful purification of the dietary constituents and the use of highly potent concentrates of the other factors of the vitamin B complex are essential for success. These workers succeeded in reproducing the ataxic symptoms without the red swollen paws, and found that pea nuts alleviated the condition.§

Pellagra.—Pellagra is a disease characterised by gastro-intestinal disorders, nervous disturbances and extensive skin eruptions, occurring in different parts of the world, particularly maize-eating countries. The nature of the causal agent is still a matter of dispute although of recent times, it has generally been held to be of dietary origin. The work of Goldberger and his colleagues[40] in America and Wilson[41] in Egypt laid the foundations for this hypothesis. The early view of Wilson (which he himself still maintains) that a shortage of protein of high biological value was responsible for the condition gave place to one of vitamin deficiency. In exploring the curative properties of different foodstuffs Goldberger reached results difficult to reconcile with the assumption that adequate protein in the diet cured pellagra. A protein such as casein showed no curative action whilst an acid extract of yeast containing little protein matter was effective in curing the disease. These results led to the postulation of the P-P factor, a deficiency of which caused the onset of the pellagrous condition. The close resemblance of the symptoms seen in the rat deprived of vitamin B_2 to those in pellagrins suggested a similarity if not identity in nature in the P-P factor and vitamin B_2. Aykroyd and Roscoe[42] pointed out that the distribution in foodstuffs of vitamin B_2 and the P-P factor was similar. Experimental black tongue in dogs, a pellagrous condition, is reproducible on pellagrin diets and is cured by a factor which, like vitamin B_2, is thermostable: yet two features, associated with human pellagra, a prevalence in maize-eating countries and the detrimental effect of sunlight have still to be correlated with these results. So far it has not been completely proved that sunlight stimulates rat dermatitis. (Hogan[43] has produced a form of dermatitis by exposure of rats to ultraviolet light.) Even more difficult to reconcile with the view that vitamin B_2 and the P-P factor are one and the same is the finding of Birch, György and Harris (1935),[44] that maize and the diets of pellagrins are rich in vitamin B_6. Dogs are found to develop black tongue when fed on a Goldberger maize diet containing large amounts of vitamin B_6. It is therefore concluded that vitamin B_6 is a factor distinct from the P-P factor and the anti-black tongue factor although the two latter may be identical. That flavin is not the P-P factor has been demonstrated by Dann who observed no improvement in pellagrins on administration of the compound. Despite such evidence indicating that human pellagra, rat dermatitis and black tongue in dogs arise from deficiency of different entities, it is also possible that one or more factors are operative in a given condition. The cures of children suffering from stomatitis by feeding such sources of vitamin B_2 as yeast and milk have been made by Aykroyd and Krishnan[45] who discuss the possibility of pellagra arising from a deficiency of more than one factor.

Vitamin B_2 and Anæmia.—The co-existence of vitamin B_2 and the extrinsic factor of pernicious anæmia in liver, liver extracts, marmite and yeast led Castle and Strauss

‡ Probably flavin was the factor under test.

§ It has recently been reported by McHenry[39] that vitamin B_4 is possibly choline, but his experiments require confirmation.

(1932)[46] to suggest that vitamin B_2 was probably the extrinsic factor upon which the intrinsic factor acted. This view has not been confirmed. Wills (1933)[47] incubated purified extracts of vitamin B_2 with the intrinsic factor and found no improvement in cases of anæmia treated with the digestion mixture. More recently Wilkinson (1935)[48] showed that flavin was ineffective in anæmia. The isolation of the anti-hæmatopoietic factor by Dakin and West (1935)[49] should throw light upon the possible relation of the anti-anæmia factor to vitamin B_2 complex.

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1 Kuhn, György and Wagner-Jauregg, *Ber.*, 1933, **66**, 1034.

2 Kuhn, György and Wagner-Jauregg, *Ber.*, 1933, **66**, 576.

3 Karrer and Schöpp, *Helv. Chim. Acta.*, 1934, **17**, 735, 1557.

4 Stern, *Nature*, 1933, **132**, 784.

5 Guha and Biswas, *Curr. Sci.*, 1934, **2**, 474.

6 Bence-Jones, *Chem. News*, 1866, **13**, 197.

7 Kinnersley, Peters and Squires, *Biochem. J.*, 1925, **19**, 404.

8 Warburg and Christian, *Biochem. Z.*, 1932, **254**, 438; *Naturwiss.*, 1932, 986; *Biochem. Z.*, 1933, **257**, 492.

9 Ellinger and Koschara, *Ber.*, 1933, **66**, 315, 808, 1411.

10 Kuhn, György and Wagner-Jauregg, *Ber.*, 1933, **66**, 317, 1577.

11 Kuhn, Rudy and Wagner-Jauregg, *Ber.*, 1933, **66**, 1950.

12 Stern and Holiday, *Ber.*, 1934, **67**, 1442.

13 Kuhn, Reinemund, Weygand and Strobele, *Ber.*, 1935, **68**, 1765.

14 Karrer, Schöpp, Benz and Pfaehler, *Helv. Chim. Acta.*, 1935, **18**, 69.

15 Kuhn and Weygand, *Ber.*, 1935, **68**, 2374.

16 György, Kuhn and Wagner-Jauregg, *Klin. Wochen*, **12**, 1241.

17 Kuhn and Rudy, *Ber.*, 1934, **67**, 1936.

18 Kuhn and Bär, *Ber.*, 1934, **67**, 898.

19 Karrer, Salomon, Schöpp, Schlittler and Fritsche, *Helv. Chim. Acta.*, 1934, **17**, 1010.

20 Karrer, Kolner, Salomon and Zehender, *Helv. Chim. Acta.*, 1935, **18**, 266.

21 Karrer and Meerwein, *Helv. Chim. Acta.*, 1935, **18**, 480.

22 Karrer and Fritsche, *Helv. Chim. Acta.*, 1936, **18**, 1026.

23 Theorell, *Biochem. Z.*, 1934, **272**, 27, 466; *ibid.*, **275**, 344, 466; *Naturwiss.*, **22**, 289.

24 Copping, *Biochem. J.*, 1936, **30**, 845.

25 Verzar and Laszt, *Zeit. f. Vitaminforsch.*, 1936, **5**, 265.

26 Kuhn and Boulanger, *Zeit. f. physiol. Chem.*, 1936, **241**, 233.

27 Chick and Copping, *Biochem. J.*, 1930, **24**, 1930.

28 Roscoe, *Biochem. J.*, 1930, **24**, 1764.

29 György, *Nature*, 1934, **133**, 498; *Biochem. J.*, 1935, **29**, 741, 760.

30 Chick, Copping and Edgar, *Biochem. J.*, 1935, **29**, 722.

31 O'Brien and Peters, 1936 (unpublished).

32 Birch, György and Harris, *Biochem. J.*, 1935, **29**, 2830.

33 Day, Langston and O'Brien, *Am. J. Ophth.*, 1931, **14**, 1005, Day and Langston, *J. Nut.*, 1934, **7**, 97.

34 Bourne and Pyke, *Biochem. J.*, 1935, **29**, 1865.

35 Birch and György, *Biochem. J.*, 1936, **30**, 304.

36 Reader, *Biochem. J.*, 1929, **23**, 689; *ibid.*, 1930, **24**, 77, 1827.

37 O'Brien, *Chem. Ind.*, 1934, **53**, 452.

38 Kline, Elvehjem and Hart, *Biochem. J.*, 1936, **30**, 780.

39 McHenry, *J. Physiol*, 1935, **85**, 344.

40 Goldberger, Waring and Willets, *Publ. Health Reps.*, Washington, 1915, **30**, 3117; Goldberger, *J. Amer. Med. Ass.*, 1922, **78**, 1676; Goldberger, Wheeler, Lillie and Rogers, *Publ. Health Reps*, 1926, **41**, 297.

41 Wilson, *J. Hyg.* (Camb.), 1921, **20**, 1.

42 Aykroyd and Roscoe, *J. Hyg.* (Camb.), 1929, **23**, 483.

43 Hogan and Richardson, *Mo. Agr. Exp. Sta. Res. Bull.*, 1936, 241.

44 Birch, György and Harris, *Biochem. J.*, 1935, **29**, 1830.

45 Aykroyd and Krishnan, *Ind. J. Med. Res.*, 1936, **24**, 411.

46 Castle and Straus, *Lancet.*, 1932, 111.

47 Wills, *Lancet.*, 1933, 1283.

48 Ashford, Klein and Wilkinson, *Biochem. J.*, 1936, **30**, 219.

49 Dakin and West, *J. Biol. Chem.*, 1935, **109**, 489.

50 v. Euler' Adler and Schlötzer, *Zeit. f. physiol. Chem.*, 1934, **226**, 88.

51 v. Euler and Adler, *Zeit. f. physiol. Chem.*, 1934, **228**, 1.

Interspecific Hybrids in *Secale* (rye).

I. *Secale cereale* × *Secale ancestrale, Secale cereale* × *Secale Vavilovii, Secale cereale* × *Secale montanum* and *Secale ancestrale* × *Secale Vavilovii* Hybrids.

By Dontcho Kostoff.

(*Academy of Sciences, Institute of Genetics, Moscow.*)

We have grown since 1931[1] (Kostoff, 1932) *Secale cereale* × *Secale montanum* hybrids and their progeny, while the other three hybrids we raised first in 1936. The cultivated species *Secale cereale* has non-brittle spikes while all the wild ryes have brittle spikes. F_1 hybrids have brittle spikes. The F_1 hybrids of the cross *cereale* × *montanum* has highly reduced fertility, while the others are highly fertile, especially the hybrid *S. cereale* × *S. ancestrale* showed an almost normal fertility. The hybrid *S. cereale* × *S. montanum* has about 75% viable pollen, while the other hybrids have a much larger percentage of viable pollen. The hybrid *Secale cereale* × *S. ancestrale* had almost normal pollen (93–97%). All hybrids were robust and produced numerous spikes.

Each *Secale* species used in our work had $n = 7$ and $2n = 14$ chromosomes[2] (Kostoff, Dogadkina and Tihonova, 1935). The F_1 hybrids *Secale cereale* × *montanum* had 5–7 bivalents, while all the other hybrids had usually 7 bivalents in the pollen-mother cells during the first meiotic metaphase. The formation of one and very often of more than one chiasmata indicates that crossing-over occurs between the chromosomes of the maternal and paternal species, which gives the possibility of recombination of characters between the cultivated and the wild ryes. The formation of seven bivalents in the hybrids studied, indicates that the genom of *Secale cereale* (S) is homologous with the genoms of *S. ancestrale, S. Vavilovii* and *S. montanum.*

The meiotic division in the hybrids: *Secale cereale* × *S. ancestrale, S. cereale* × *S. Vavilovii*, and *S. ancestrale* × *S. Vavilovii* proceeds almost normally. Only slight irregularities were found, that lead occasionally to formation of non-viable gametes. Meiotic division in *S. cereale* × *S. montanum*, however, had somewhat more irregularities. The occurrence occassionally of

Fig. 1.

Fig. 2.

Fig. 1.—Meiotic metaphase from a pollen-mother cell of F_1 *Secale cereale* × *Secale ancestrale* hybrid with 7 bivalents.

Fig. 2.—Meiotic metaphase from a pollen-mother cell of F_1 *Secale cereale* × *Secale Vavilovii* hybrid with 7 bivalents.

two univalents or an unsimultaneous separation of the bivalents during the first meiotic divisions were chiefly the causes for the irregularities observed. The occurrence of a relatively large percentage of abortive pollen in this hybrid seems to be partly due to the irregular meiosis and partly to the retardation of certain processes proceeding in the anthers of the hybrid plants (Kostoff, 1932). The relatively high sterility of this hybrid is probably due not only to the relatively larger percentage of abortive pollen (than in the other hybrids) but to certain sterility factors of the type described by East in *Nicotiana*, which are also responsible for incompatibility of the cultivated rye when self-pollinated.

The majority of the plants obtained from selfing *S. cereale* × *S. montanum*, and especially those produced from the back crosses of *S. cereale* × *montanum* to *S. cereale* are more fertile than the F_1 hybrids. In the F_4 and F_5 generation we produced plants and lines which were very productive. Some plants of the F_2 generation were, however, completely sterile. We found even heteroploid forms in F_2 generation with 15 somatic chromosomes. One plant was found,

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[1] Kostoff, D., 'Pollen abortion in species hybrids," *Cytologia*, 1932, 3, 337–39.

[2] Kostoff, D., Dogadkina, N., and Tihonova, A., "Chromosome number of certain *Angiosperm* plants (*Nicotiana, Petunia, Oxalis, Secale* and *Punica*)," *Compt. Rend. Acad. Sci.*, URSS, 1935, 3, (8), No. 9, pp. 401-404.

that had 23 somatic chromosomes. These aberrants are unavoidable sequence from the irregularities in the reduction division of F_1 hybrids. The aberrant plants were completely sterile. The extra chromosome in the trisomics was normal in size, but it was not a fragment as in Gotoh's (1924, 1932) forms.

Trisomic plants have probably originated after fusion of one gamete having 8 chromosomes with a normal gamete having 7 chromosomes. Gametes with 8 chromosomes can be formed when 6 bivalents and 2 univalents are formed during the first meiosis if both univalents go to one of the poles ($6 + 2 = 8$).

The plant with 23 somatic chromosomes has probably originated after fusion of one gamete having 16 chromosomes with a normal gamete having 7 chromosomes. Gametes with 16 chromosomes can originate from an 8 chromosomic nucleus formed after a chromosome distribution of 8–6 instead 7–7 during the first meiosis as just mentioned and then a doubling following non-occurrence of the second division.

Hybrids between cultivated rye and *S. montanum* has been occasionally produced by plant breeders (Duka). *S. montanum* is a perennial species and one can combine this character with the characters of the cultivated rye by hybridization. We wish to call the attention of the plant breeders that *S. ancestrale* might be used with success in plant breeding work when crossed with the cultivated rye. *S. ancestrale* is a productive and robust species and seems to be one of the most closely related species to the cultivated rye. *S. Vavilovii* behaves in the hybrids with cultivated rye in a similar way as *S. ancestrale*, but it is not so robust and so productive as *S. ancestrale*.

We are greatly indebted to Com. Omelnitzkaya, A. Tihonova, N. Dogadkina and Z. Vishemirskaya for help throughout this work.

Liesegang Rings and the Influence of Media on their Formation.

By Dr. B. N. Desai.

(*Meteorological Office, Karachi.*)

THE role of gels in the production of banded precipitates has been the subject matter of many investigations. In the *Lucknow University Studies** Dr. A. C. Chatterji has given a summary of investigations carried out by him in collaboration with Dr. N. R. Dhar and others on "Liesegang rings and the influence of media on their formation". From the results of lead chloride, lead iodide and silver molybdate rings in agar, gelatine, silicic acid and starch gels, it has been inferred that with the same sparingly soluble precipitate, the character of the ring considerably changes when produced in different gels. In some, it is found very difficult to produce rings, while in others the formation of rings is very easy.[1] The gel is considered to have a specific influence and is by no means an indifferent medium which prevents mixing or merely fixes the precipitate at the position of formation.

Chatterji and Dhar attributed the specific nature of the gel to its protective effect in ring formation. According to their theory[2] of the Liesegang phenomenon, the rings are formed by the coagulation of a peptised sol. The coagulated mass in the course of its formation and when precipatated adsorbs and coagulates completely or partially the sol of the same substance from the neighbouring layers. Their theory differs from that of Ostwald[3] according to which the gel produces a supersaturated solution of the substance to be deposited in bands which are actually produced when the supersaturation is released and from that of Bradford[4] according to which one of the reacting substances is adsorbed by the layer of the precipitate, the result being a zone practically free from it, so that the clear spaces between the rings are at once accounted for.

In support of their theory of Leisegang rings Chatterji and Dhar[5,6] have recorded conductivity and E.M.F. measurements which show that Ag_2CrO_4, AgCl, AgCN, AgBr

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* Faculty of Science, 1934–35 Session, No. 7, July 1936.

and AgI in gelatine gel are almost wholly in a state other than ionic. The results of Williams and Mackenzie,[7] Bolam and Mackenzie,[8] Desai and Nabar,[9] and Bolam and Donaldson,[10] indicate, however, that silver chromate is present in gelatine mainly in ionic condition. Naik, Desai and Desai[11] have subsequently found that silver chromate in gelatine is mostly in a condition other than ionic. These results of Desai and co-workers have been considered by Chatterji as corroborating his own work and hence supporting Dhar and Chatterji's theory of Liesegang rings.

It has to be pointed out that more recently Khanolkar, Barve and Desai[12] have shown that by suitable adjustment of the (i) temperature of the experiments, (ii) pH of the gelatine, (iii) concentration of the reactants and (iv) amount of gelatine, conditions can be so changed that the conductivity may (*a*) not decrease while the yellow colour persists, (*b*) decrease sometime after the colour change from yellow to red or (*c*) not change at all in spite of the colour change, the supersaturation being largest for case (*a*) and nil for case (*c*). It has been mentioned by Chatterji[13] that the percentage of silver chromate in condition other than ionic can be decreased by increasing the acidity of the medium due to enhanced solubility of the silver salt in acids. On the other hand Khanolkar, Barve and Desai[12] have shown from experimental results that while the percentage of silver chromate in non-ionic condition in the yellow mixtures (*i.e.*, before the appearance of the red colour) decreases with an increase in the acidity of gelatine solution, it is at a maximum in the red mixtures for pH value 5·75 (when conductivity does not change on standing). The conclusions of Chatterji and Dhar about the condition of silver chromate in gelatine are not therefore supported by the latest results of Desai and his co-workers.

It is doubtful if the theory advanced by Dhar and Chatterji about the formation of Liesegang rings in gels can be taken as satisfactory. According to Bradford[14] any substance can give a banded precipitate if it is obtained in a fine condition. The gels when used as media for the formation of rings, cause the substance to be deposited in a very fine condition, the fine particles being not always charged. According to the theory of Chatterji and Dhar one would expect that rings are not formed in cases where the substance to be deposited cannot previously be produced in colloidal condition.[15] Lloyd and Moravek[16] have, however, shown that periodic precipitation can be obtained even in gaseous, fluid and solid media besides gels; they have further shown that the effects of spatial relations, surface, concentrations of the reactants, temperature at which the reaction takes place, forward and backward diffusion, etc., have also to be taken into account besides the effects of media and of adsorption by the precipitate. From a critical examination of the various theories which have been put forward by different investigators it may be concluded that no single theory can explain all the known facts about banded precipitation.

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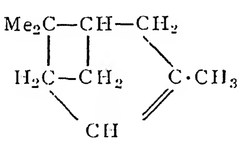
1. Chatterji and Dhar, *Koll. Zeit.*, 1926, **40**, 97.
2. *Ibid.*, 1925, **37**, 2, 89.
3. W. Ostwald, *Zeit. Phys. Chem.*, 1897, **23**, 365.
4. Bradford, *Biochem. Journ.*, 1916, **10**, 169; 1917, **11**, 14, 157.
5. Dhar and Chatterji, *Trans. Far. Soc.*, Oct. 1926.
6. Chatterji and Dhar, *Jour. Ind. Chem. Soc.*, 1930, **7**, 177.
7. Williams and Mackenzie, *J. C. S.*, 1920, **177**, 844.
8. Bolam and Mackenzie, *Trans. Far. Soc.*, 1926, **22**, 162; 1928, **24**, 50.
9. Desai and Nabar, *Nature*, 1931, **127**, 628; *Jour. Ind. Chem. Soc.*, 1932, **9**, 141.
10. Bolam and Donaldson, *Trans. Far. Soc.*, 1933, **29**, 864.
11. Naik, Desai and Desai, *Jour. Ind. Chem. Soc.*, 1934, **45**, 11.
12. Khanolkar, Barve and Desai, *Proc. Ind. Acad. Sci.*, 1936, **4**, **A**, 468.
13. Chatterji, *Lucknow University Studies*, No. VII.
14. Bradford, *J. Soc. Chem. Ind.*, 1929, **48**, 79.
15. Dhar and Mitra, *Nature*, 1932, **129**, 761.
16. Lloyd and Moravek, *J. Phys. Chem.*, 1931, **34**, 1512.

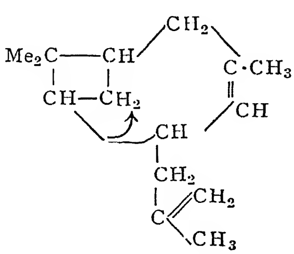
LETTERS TO THE EDITOR.

The Structure and Probable Biogenisis of β–Caryophyllene.

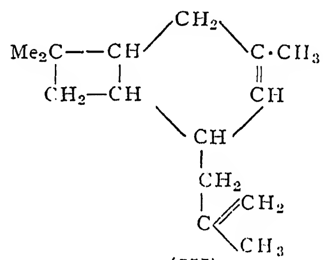
THE structure (III) assigned to β-caryophyllene by Ruzicka[1] has also been shown by Ramage and Simonsen[2] to be the most satisfactory representation. There seems to be some additional indirect evidence pointing to the correctness of the structure of Ruzicka [besides its being visualised as in (IV) to be made up of a unit of ocimene and one of isoprene], in that it has a very close resemblance to the bicyclic terpene, "orthodene" (I) which Fujita[3] has isolated from the oil of *Orthodon lanceolatum* along with caryophyllene. The similarity between the two structures (I) and (III) and the occurrence of the two terpenes in the same oil suggest that biogenetically both these compounds should be closely related. It is likely that β-caryophyllene is formed from orthodene by the addition of an isoprene unit (or its biological equivalent), probably by the isomerisation of the intermediate form (II).



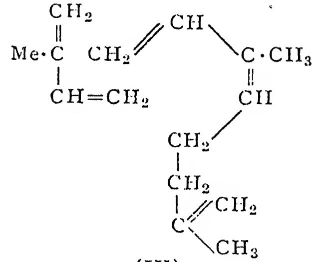
(I)



(II)



(III)



(IV)

It is significant that the formation of β-caryophyllene according to this mechanism is quite in conformity with the positions of the double bond and the isopropenyl group in the formula of β-caryophyllene as advanced by Ruzicka.

K. GANAPATHI.

Department of Organic Chemistry,
Indian Institute of Science,
Bangalore,
May 5, 1937.

1 *J. Soc. Chem. Ind.*, 1935, **54**, 509.
2 *J. C. S.*, 1937, 73.
3 *Am. Chem. Abs.*, 1934, **28**, 1470; *J. Chem. Soc.*, Japan, 1933, **54**, 1811.

Crystalline Globulin from *P. aconitifolius* Jacq.

A crystalline globulin has been isolated from the seeds of aconite bean, *P. aconitifolius* Jacq. The seed meal was extracted with hot (60° C.) 5% sodium chloride solution. The clear filtered extract was diluted with hot distilled water until a slight turbidity appeared; it was warmed on the water-bath till it became clear and allowed to cool gradually. The precipitated protein was separated on the centrifuge, redissolved in hot saline and reprecipitated as above, and the treatment was repeated for a third time. The protein was repeatedly washed with distilled water till free from chloride.

Fig. 1.
Betweeen crossed nicols × 45

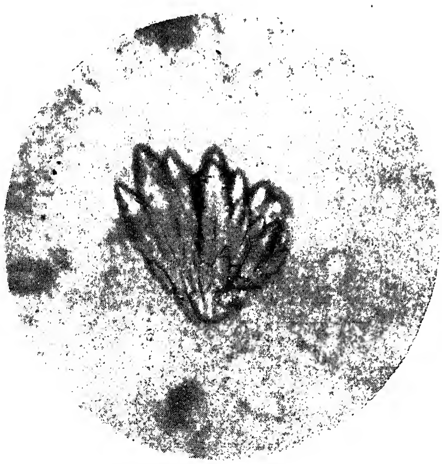


Fig. 2.
× 120

The globulin when examined under a polarising microscope showed a spherulitic structure (Fig. 1), and on standing the spherulites developed into radiating needles (Fig. 2).

The crystalline globulin was dried in the usual manner and tested for its purity. Tyrosine and tryptophane were also estimated by the colorimetric method of Folin and Merenzi.[1] Results are incorporated in Table I.

Table I.

Ash. (% of Globulin)	Total N. (% of Globulin)	Tyrosine. (% of Total Nitrogen)	Tryptophane. (% of Total Nitrogen)
0·3	15·99	2·6	0·5

Kamala Bhagvat.

[1] Folin and Merenzi, *J. Biol. Chem.*, 1929, **83**, 103.

Volatilisation of Ammonia from Indian Soils.

During the past few decades, a large number of workers, from different parts of the world, have drawn attention to loss of nitrogen from soils and consequent diminution in fertility. Several theories have been advanced to explain the phenomenon but the mechanism of loss has not yet been fully understood.

Hutchinson[1] drew attention to possible loss of nitrogen through volatilisation of ammonia from soils treated with large excess of organic manures. Sreenivasan and Subrahmanyan[2] noted that there was considerable loss of ammonia from swamp soil treated with organic manures, especially those with narrow C–N ratios. They showed that similar losses—though not so pronounced—occur even under conditions of dry cultivation.

Gundu Rao and Subrahmanyan[3] observed that there was volatilisation of ammonia even from soils treated with ammoniacal fertilisers. The possibility of such a loss is now recognised and, indeed, in Egypt and Sudan the fertiliser is buried in the soil immediately after application. It is very doubtful, however, whether even this is effective in preventing loss of nitrogen. The following results relating to some representative Indian soils will illustrate the position :—

The soils (29 g. each) were treated with 10 c.c. each of an aqueous solution of ammonium sulphate containing 3×10^{-4} g. of nitrogen per c.c. This would correspond to 150 mg. of nitrogen per kg. of soil. The experiments were carried out in small dishes provided with lids. Ammonia lost by volatilisation was estimated by absorption in filter paper (Whatman, No. 30 or 41) previously moistened with known quantities of standard acid. (The technique of estimation is described in detail elsewhere.) Temperature, 23–27°C.

TABLE.

Soil	Ammonia lost (as mg. of N per kg. of Soil) at the end of Time in days				
	1	3	5	7	10
1	27·8	36·7	43·1	49·1	53·2
2	48·1	91·2	105·2	119·1	128·0
3	38·0	79·8	98·8	111·5	121·6
4	Nil	5·1	10·1	12·7	14·0
5	27·8	43·1	52·0	57·0	60·8
6	13·5	25·3	30·4	35·4	37·6
7	17·8	29·1	39·3	45·6	48·1
8	49·4	92·5	111·5	125·4	139·4
9	26·6	48·1	59·6	67·2	72·6
10	36·7	68·5	86·1	97·6	107·7

1. Rice land from Gurdaspur Dt., Punjab; 2. Clay soil, Fruit Farm, Mirphurkas, Sindh; 3. Calcareous soil, North Bihar; 4. Paddy soil, Dacca; 5. Paddy soil, Mandalay; 6. Laterite soil, Chota Nagpur; 7. Upland soil, Cuttack, Orissa; 9. Paddy soil (alkaline), Travancore.

The other results may be summarised as follows:—(1) In presence of adequate amounts of moisture and on prolonged exposure, almost all soils treated with ammoniacal fertislisers lose ammonia, the extent of such loss depending on the nature of the soil and the previous treatment received by it. Certain types of soils—especially alkaline or calcareous—lose nitrogen very rapidly. In some cases, ammonia is given off almost immediately after addition of the fertiliser. Under similar conditions, black soils generally suffer heavier losses than red ones. The loss is much less from laterite and acid types of soils and in some cases there is practically no loss after the first few days. (2) The extent of loss increases (up to a point) with the concentration of the ammonium salt. Increase in the proportion of soil reduces the loss in some cases (especially when the soils are acid), but enhances it in others. (3) Volatilisation of ammonia is due to purely chemical agencies. Similar results are obtained from fresh as well as sterile soils. (4) Basal dressings of lime (slaked or unslaked) facilitate liberation of ammonia and consequent volatilisation from all types of soils. (5) Increased moisture content helps to retain ammonia to some extent, but is not entirely effective in preventing the loss. (6) Volatilisation is comparatively slow at lower temperatures (23–27° C.), but proceeds very rapidly at 37° C. and above, which are usually attained in the tropics. (7) The rate of loss varies with different ammonium salts. Thus, the phosphate (diammonium salt) loses ammonia more rapidly than the sulphate or the chloride. (8) Addition of cellulosic materials is fairly effective in checking volatilisation, especially after the material has undergone some preliminary decomposition.

The above observations would appear to be of considerable practical significance, especially to tropical agriculture. They account, at least partly, for the low level of nitrogen ordinarily found in such soils. They also show why ammonium salts are not so effective or liming so beneficial, in tropics as observed in temperate regions. They would also provide an additional reason for the physiological acidity of ammonium salts which has so far been considered to be exclusively due to preferential intake of ammonium ion by plants.

Further researches are needed to determine the extent of loss under field conditions especially when ammoniacal fertilisers are applied as top dressings; whether the ammonia evolved from the soil is partly assimilated by the growing plant. The mechanism of loss, as also its bearing on other nitrogen transformations such as nitrification, also require elucidation. The mannner in which the added cellulosic materials check the volatilisation would also require some explanation. Attempts should also be made to minimise the loss under

different soil conditions without abnormally increasing acidity which would be inimical to most crops.

The foregoing and allied problems are now under investigation.

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[1] Hutchinson, C. M., *Mem. Dept. Agric. India., Bact. Ser.*, 1910-11, **1**, 41.

[2] Sreenivasan, A., and Subrahmanyan, V., *Jour. Agric. Sci.*, 1935, **25**, 6.

[3] Cited from Sreenivasan and Subrahmanyan, *loc. cit.*, p. 20.

Observations on the Microflora of the Punjab Soils.

THE extreme temperature conditions in the Punjab, *i.e.*, very hot in summer and very cold in winter months present unique conditions for the study of the Soil Microflora. During the course of last year quantitative, and to some extent qualitative, studies were undertaken of Soil Bacteria, Fungi and Actinomycetes, in this subtemperate region of the globe. The most salient results may be summarised as under and the fuller details about them will appear in due course.

Soil Bacteria.—Fortnightly quantitative estimations, on Thornton's agar count medium (1922) have revealed that there are two maxima for the bacterial numbers in the Punjab soils, one towards the end of April or beginning of May, and the other is sometimes in October. Along with this there are two minima as well, one in the end of January and the other in the beginning of August. The bacteria hence show a marked periodicity in the different seasons of the year, though our maxima and minima are different from those reported by some of the European and American workers. The variations of the bacterial numbers in this soil cannot be explained entirely to be due to any of the physical factors individually, but may be the result of the accumulative effect of all the factors of which the temperature seems to be the most important. No extensive studies of the Soil Bacteria have been made but a spreading type was observed to appear and disappear at different seasons of the year, it being more prominent in spring and autumn and almost disappearing in winter and high summer. An extensive study, however, is desired for establishing definite conclusions on this subject.

Soil Fungi.—The quantitative estimations in the case of soil fungi on acid Coon's agar medium do not support the view that a definite periodicity in the numbers exist such as is found in the case of bacteria. The numbers seem to scatter about a mean value throughout the whole year. Various new genera of fungi which have not been reported before in the soil have been isolated, such for example, *Choanophora* sp., *Fusicoccum* sp., *Cytospora* sp., *Striochæte* sp., *Mapea* sp., *Stemmaria* sp., etc. Particular attention was paid to the occurrence of Aspergilli and Penicillia during the different seasons of the year. The results corroborate the view of Waksman (1932) and later by Galloway (1936) that Aspergilli are more abundantly found than Penicillia in the warmer soils, the latter being more prominent during winter months. The other common soil forms may be listed in the following order according to their intensities of occurrence. *Fusarium* sp., *Alternaria* sp., *Spondylocladium* sp., *Rhizopius* sp., *Mucor* sp., *Phoma* sp., *Trichoderma* sp., *Stemmaria* sp., *Monilia* sp., *Sordaria* sp., *Heterosporium* sp., *Mapea* sp., *Spicaria* sp., *Choanophora* sp., *Cunninghemella* sp., *Striochæte* sp., *Helminthosporium* sp.

Soil Actinomycetes.—Fortnightly estimations of the soil actinomycetes on alkaline Coon's agar medium show that they do not show any periodic phenomenon. The variations in numbers during the different seasons of the year can be accounted on the random sampling basis. It seems that fungi and actinomycetes are very resistant organisms and are not so readily affected by external conditions as the bacteria.

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Department of Botany,
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Lahore,
April 22, 1937.

[1] Thornton, H. G., "On the development of standardized agar medium in counting Soil Bacteria," *Annals of Applied Biology*, 1922, **9**.

[2] Waksman, S. A., *Principles of Soil Microbiology*, 1932.

[3] Galloway, L. D., "Indian Soil Fungi," *Ind. Journ. Agric. Sci.* 1936, **6**.

The Occurrence and Inheritance of Purple Pigment on the Glumes of Sorghum Close on Emergence from the Boot.

SORGHUMS are divisible into two sects, *Para-Sorghum* and *Eu-Sorghum*.[1] In the *Para-Sorghum* group, in the species *Sorghum versicolor* J. N. Anderss, *S. diminiatum* Stapf and *S. purpureo-sericeum* Aschers. et Schweinf. the glumes though they emerge green in colour from the boot, turn purple the day after emergence. In the plants belonging to these species observed at Coimbatore, leaf-sheaths do not develop the purple colour.

In the *Eu-Sorghum* group to which all the grain sorghums belong, purple pigment manifests itself concurrently on the leaf-sheath and on the glumes when the factor P is present. This pigment is reddish purple or blackish purple according as the factor Q is present or not.[2] In the leaf-sheath the colour appears at the short-blade stage. The time at which the pigment appears on the body of the glume is about three weeks after emergence of the head, when the flowering is over and when grains are in the dough stage. Till then, the glumes are green.

In certain grain sorghums from Nigeria, belonging to the species *Sorghum guineense* Stapf and *S. caudatum* Stapf a new experience has been met with. In these varieties the glumes put on a purple colour just immediately after emerging from the boot. Even inside the boot the tops of the glumes are coloured purple. The manifestation of purple on the leaf-sheath takes place as usual, about the heading stage.

In *S. guineense* Stapf, crosses between Emerging Purple and Emerging Green types were made. The first generation showed the complete dominance of emerging purple. In the second generation there was a simple mono-hybrid segregation (47 emerging purple and 18 emergimg green). A third generation of four emerging purple and one emerging green selections was raised. The green was pure. Of the four purples two pure and the other two segregated giving 68 purples and 24 greens.

A new gene, G_{ep}, Nigerian in origin is responsible for the manifestation of purple pigmentation on the glume at emergence from the boot—an acceleration of the usual manifestation at the dough stage.

Since all the glumes turn purple at the dough stage, care was taken to note this character soon after the emergence of the head. After the dough stage the two groups keep on the same tint of purple. When awns are present, the subules take on the purple pigment when the glumes colour on emergence. The colour on the subules, however, fades on drying. Whether the colour manifests late or early on the glumes of the sessile spikelet, the pedicelled spikelets remain unaffected by the pigment.

The colour at emergence may be reddish purple or blackish purple and in family No. A.S. 4948 the following di-hybrid segregation, proving the independent inheritance of the factors Q and G_{ep}, have been obtained.

Selection No.	Glumes Purple at emergence G_{ep}		Glumes Green at emergence g_{ep}	
	Reddish Purple Q	Reddish Purple q	Blackish Purple Q	Blackish Purple q
A.S. 4948	67	21	21	7

To sum up: A factor G_{ep} imparts purple pigment to the glumes of sorghum immediately on emergence of the head from the boot. G_{ep} is a simple dominant to g_{ep} (manifestation of purple pigment at the dough stage) and is independent in inheritance to the Q factor determining the nature of the pigment, whether reddish or balckish purple.

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B. W. X. PONNAIYA.

Millets Breeding Station,
Coimbatore,
May 10, 1937.

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1 Snowden, J. D., *The Cultivated Races of Sorghum*, 1936.

2 *Ind. Jour. Agric. Sci.*, 1933, **3**, 589.

Labial Glands in Coleoptera.

"LABIAL glands are present in all the principal orders of insects except Coleoptera," says Snodgrass (1935). Imms (1925) remarks "Although these glands appear to be often wanting in Coleoptera, they are present in the majority of insects and assume a great variety of form and

structure." My recent studies on the mouth-parts of the Coccinellid beetles, however, have revealed the presence of well-developed labial glands in *Coccinella septempunctata.* Subsequent search for these glands in more than half a dozen species has shown that probably labial glands are of universal occurrence at least in the family Coccinellidæ amongst the Coleoptera.

In *Coccinella septempunctata* (Figs. A and B) as well as in other species I have studied, these glands are paired structures opening separately at the base of the hypopharynx between it and the labium. Each gland consists of globular lobes with long fine ductules which open at various levels into a long thick common duct. The two common ducts of the two glands lie quite symmetrically on either side of the median axis of the labium.

Fig. A.

Section of the head-capsule of *Coccinella septempunctata* showing the Labial Glands *in situ*. *L.*, Labium; *Gl.*, Labial glands.

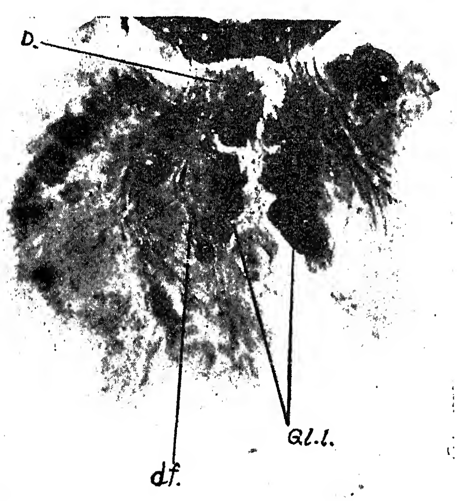

Fig. B.

Labial glands of *Coccinella septempunctata* photographed under the high power of the microscope. *Gl. l.*, globular lobes of the glands; *dt.*, ductules of the lobes; *D.*, main duct of the gland.

Besides these labial glands, there are also in *C. septempunctata* as well as in other species I have studied, very long, thin, tubular glands associated both with the mandibles as well as with the maxillæ. The structure of the maxillary and the mandibular glands is similar, and closely resembles that of the so-called salivary glands of Tenebrionidæ (Gupta, 1937), *Epilachna indica* (Pradhan, 1937), *Cæcilius* sp., fam. Psocidæ (Kolbe) and some other species of Coleoptera investigated by Dufour (1824).

My findings on these various glands lead me to two important conclusions: (1) that the labial glands are not always absent in Coleoptera, (2) that the so-called tubular salivary glands described in the Coleoptera by the various authors referred to above are not true salivary glands, homologous with those of a generalised insect like the cockroach. The second conclusion is based on the following considerations:—(*a*) the salivary glands of the generalised insect are true labial glands; (*b*) the tubular glands referred to as salivary glands by the various authors are clearly traceable in the Coccinellidæ to the bases of the maxillæ and the mandibles; (*c*) these tubular glands co-exist with the true unmistakable labial glands which show an absolutely different structure. Thus there is need to search for the true salivary glands even in those species in which the so-called tubular salivary glands have been noticed before.

The full paper containing a detailed description of these glands and further considerations on their theoretical significance will shortly appear elsewhere.

I wish to record my respectful thanks to Prof. K. N. Bahl and Dr. H. S. Pruthi for the indispensable help they give me in my research. My thanks are also due to M. L. Bhatia, Esq., for his kind help.

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May 5, 1937.

Serial Experiments.

The review of 'A Hand-Book of Statistics for use in Plant Breeding and Agricultural Problems', by F. J. Shaw appears in the March issue of *Current Science*. About the illustration* in the section of Serial Experiments the reviewer (D. S. R.) writes, "The sum of squares due to blocks is taken as though there are 5 blocks, whereas there are actually 30 blocks. Because a block in Table XLVI is not identical in all the seasons and in the two localities in the sense that a variety is, the necessary correction should be made when using the book."

By suggesting a correction to write the S. S. for blocks as

	d. f.	S.S.
Blocks ..	24	5120·831
instead of as		
Blocks ..	4	197·774
Blocks × Localities	4	735·224
Blocks × Seasons	8	3175·232
Blocks × Seasons × Localities ..	8	1012·601

the reviewer only partially gets over the unreal difficulty of attaching meaning to such items in the analysis of variance table as depend for their meaning on the arbitrary numbering of blocks in different years and localities. There are four other items which depend for their meaning on the arbitrary numbering of blocks, namely

	d. f.	S.S.
Blocks × Varieties	48	1112·562
Blocks × Varieties × Seasons ..	96	2231·135
Blocks × Varieties × Localities ..	48	897·245
Blocks × Varieties × Seasons × Localities ..	96	1979·310

and if the correction is to be complete it is necessary to replace the four items by one single item, namely

	d. f.	S.S.
Error	288	6220·252

Although it is unnecessary to split the block S.S. (24 *d.f.*) and the error S.S. (288 *d.f.*) it is not incorrect to divide them in the way done by Shaw. The use of the word 'correction' by the reviewer is in this sense misleading.

A mistake has been made not in the analyses of Variance Table but in its interpretation in tests of significance. In an experiment in randomised blocks in which varieties are assigned wholly at random within each block, the degrees of freedom corresponding to the interaction between blocks and varieties are due to the differences in fertility between different plots within the same block and are therefore wholly available for providing the estimate of error. In the present illustration there will be 48 *d.f.* available for estimating the error in each of the six single experiments, and 288 (48×6) for estimating the error in the aggregate as against only 96 allotted by the author. By assigning only the third order interaction to the residual error, Shaw fell into the error of basing the error-proper on only a partial number of *d.f.* As a consequence of this the level of significance was much too raised and the tests were made more stringent than were originally intended.

In the example under discussion, the number of *d.f.* for error as shown in Shaw's book is already sufficiently large and there is no likelihood that any of his conclusions will be materially altered due to the rise in the significance level. But nevertheless it is of real value to guard against this mistake which may seriously affect interpretation in other serial trials where the *d.f.* for error are relatively few.

P. V. Sukhatme.

Imperial Institute of Sugar Technology, Cawnpore,
April 16, 1937.

In the review of the book under reference, there was pointed out the need for correction of the analysis of variance of a serial experiment therein discussed. Within the scope of a review, it was deemed expedient to just invite attention to the fictitious system of blocks employed in the analysis of the results, leaving it to those interested in the subject to make the necessary alterations. Dr. Sukhatme has now volunteered to set forth these alterations in detail. But it was unnecessary for him to have mentioned that "By suggesting a correction to write the S. S. for blocks as......the reviewer only partially gets over......" Because, in the

* The illustration is taken from an actual experiment conducted by Mr. R. D. Bose, Pusa, and had originally appeared in the *Journal of Agriculture and Live-Stock of India*, 5, Part VI.

the review there was not mentioned any specific correction but that the "necessary correction should be made" in the table after realising the fundamental error about blocks. As Dr. Sukhatme further expresses the view that these corrections are unnecessary, the argument is now furnished to urge the necessity for correction mentioned in the review.

The five blocks constitute an entirely fictitious system. *The numbering of the blocks as 1, 2,......5 in any year or locality is perfectly arbitrary. To realise this, is to appreciate the contention that the concept of blocks as employed in the analysis conveys no meaning.* It follows then that every entry in the table associated with blocks, namely "Blocks", "Blocks × Localities", etc., is absolutely without meaning, and therefore not as good as being only "incorrect". The corresponding sums of squares must be absorbed in the true block and error sums of squares. This is not a matter of choice but one of absolute necessity.

If on realising the initial mistake about blocks the error sum of squares is recalculated to absorb "Blocks × Varieties", "Blocks × Varieties × Seasons", etc., there does not arise the further question raised by Dr. Sukhatme, namely, "A mistake has been made not in the analyses of Variance Table, but in its interpretation in tests of significance."

D. S. R.

April 30, 1937.

A Note on the High Insulation of Outdoor Antennas.

By C. V. Rajam.

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THE condition of high insulation of an outdoor antenna is difficult to secure in practice and particularly in tropics where the atmospheric humidity and temperature are comparatively high. The problem becomes quite serious in a place situated near a tropical sea and great difficulty was experienced by the author at the Presidency College, Madras (situated very near the sea), in maintaining the insulation of a long outdoor aerial (used in the investigations on the waveforms of atmospherics) at any satisfactory value (above 10 megohms). Aerial insulators made of glass, pyrex glass and quartz were tried and found inadequate for the purpose. Though with pyrex and quartz insulators the aerial insulation was found high to begin with, in the course of a few days the insulation deteriorated so as to exhibit a diurnal variation with a maximum (quite high) at noon, and a low minimum (a megohm or even less) at the late hours of the night. On close study, it was found that the slow deterioration and the characteristic diurnal variation was due to the surface leakage, resulting from the surface film of moisture together with a small amount of dirt and salt formed over the surfaces of the aerial and lead-in insulators, and not due to any deterioration in their volume resistivity. The suitability of sulphur insulators for securing high insulation has been suggested by previous experimenters[1,2] but the details of the practical design and method of construction are found meagre in the literature. It is the purpose of this note to describe in detail the practical design and construction of a successful form of aerial and lead-in insulators made of ebonite and sulphur.

In the design of the high-insulation aerial insulators two principal conditions, namely, (1) high surface resistivity combined with adequate volume resistivity and (2) sufficient mechanical strength to stand the tension of the aerial wire, should be satisfied. Though sulphur possesses high surface resistivity it is not mechanically strong enough to be used in the form of aerial insulators and hence it is necessary to use it in the form of a coating or flange with another insulating substance like ebonite so that the insulator made up of the two substances may exhibit a high surface resistivity as well as sufficient mechanical strength. Ebonite is found most suitable for this purpose as it possesses good volume resistivity and exhibits a strong adhesive property towards sulphur while retaining it over a good range of temperature as the thermal expansion of sulphur and ebonite are more or less the same. It may be pointed out that unless the coefficient of the thermal expansion of the insulating material used in conjunction

[1] Wilson, C. T. R., *Phil. Trans.*, 1921, **221 A**, 73.

[2] Appleton, Watt and Herd, *Proc. Roy. Soc.*, 1926, **3 A**, 615.

with sulphur is very nearly equal to that of sulphur, cracks will be developed under the variations of atmospheric temperature and this will lead to a quick deterioration of the surface resistivity of the insulator. After experimenting with different designs and methods of construction the following was found most suitable for securing an aerial insulator with high surface resistivity and mechanical strength to stand the tension of quite long aerials.

As illustrated in Fig. 1 an ebonite rod of $2\frac{1}{2}''$ in diameter and about $9''$ in length is turned in a clean lathe to form three grooves each one measuring $\frac{1}{2}'' \times \frac{1}{2}''$ at a distance of $1\frac{1}{2}''$ from each other along the length of the rod. These grooves are cut to form the wide flanges of sulphur over a clean ebonite surface $\frac{1}{2}''$ below the general surface of the ebonite rod, as such a design imparts high surface resistivity and good mechanical strength to the wide flanges of sulphur.

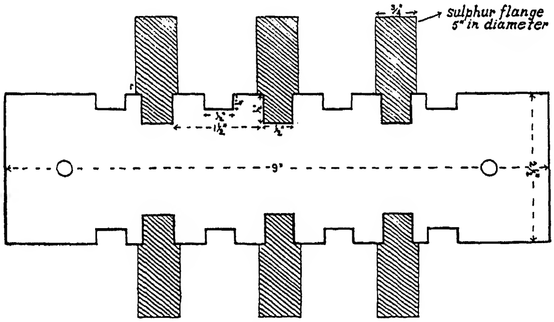

Fig. 1.

Between these three flange grooves, three more shallow grooves measuring $\frac{1}{2}'' \times \frac{1}{4}''$ are cut so that the continuity of the ebonite surface between any two sulphur flanges is intercepted by a shallow groove. Two more shallow grooves are cut at a distance of $1\frac{1}{2}''$ from each end of the rod for the same purpose and the holes for the aerial are bored beyond these grooves as shown in Fig. 1.

The formation of the wide flanges of sulphur measuring $5''$ in diameter and $\frac{3}{4}''$ thick around three deep grooves on the ebonite rod should be carried out carefully so that they are finished without any internal pores or cracks while at the same time having a highly polished surface. The above two qualities of the sulphur flanges are found essential to secure the highest surface resistivity to moisture as well as the constant high insulation property of the insulator as a whole. For this purpose a polished metallic mould in the form of a shallow circular vessel ($5''$ in diameter and $\frac{4}{5}''$ depth) having a central hole just allowing the ebonite rod to pass through it, is fixed round one of the three deep grooves. Sulphur which is melted in a clean vessel is poured little by little in the mould so as to form a uniform non-porous flange from the full depth of the groove. The sulphur used for this purpose should be pure in the form of rolls and it should be melted in such a manner as to avoid the formation of red sulphur which is found detrimental for securing the best insulating properties of the sulphur flange. By heating the sulphur in a wide vessel over a sand-bath and keeping always an excess of solid sulphur in the melting pot it is easy to avoid the formation of red sulphur. Again only a small quantity sufficient to form a thin layer of the flange should be poured at a time to avoid any pores in the flange and after allowing it to solidify the process should be repeated to form the required thickness of the flange. After allowing the sulphur flange to solidify and cool for about three hours the mould is easily removed leaving the sulphur flange firmly adhering to the ebonite rod and in this manner the other two flanges are formed. The aerial insulator with the properly formed sulphur flanges around the ebonite rod exhibits remarkably high insulating properties and mechanical strength under all conditions of the weather. A photograph of this high insulation aerial insulator is shown in Fig. 2.

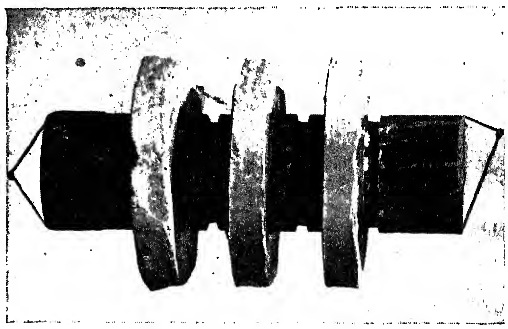

Fig. 2.

The lead-in insulator to be used with the above aerial insulators is also designed and constructed on similar lines. In this case (Fig. 3) an ebonite disc of $9''$ diameter and $\frac{3}{4}''$ thick is taken and leaving a central plat-

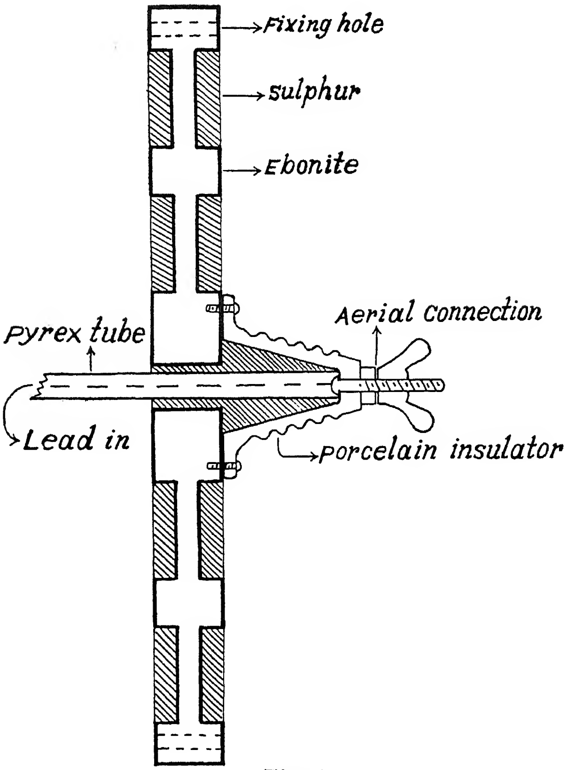

Fig. 3.

form of about 2″ diameter, two concentric grooves measuring $1\frac{1}{2}'' \times \frac{1}{4}''$ are turned on both the surfaces of the disc. The grooves are filled with pure sulphur in the manner already described and the central platform is fitted with a high grade porcelain or pyrex glass insulator as illustrated in the figure. The lead-in insulator from the terminal of the porcelain insulator is taken through a pyrex glass tube passing through a central hole in the ebonite disc and being fixed in position by the sulphur filling the space around the tube. This lead-in assembly is fixed to a window pane in which a hole of about 8″ diameter has been already cut so that the surfaces of the sulphur rings or the lead-in tube do not touch the earthed surface. The system of aerial insulation consisting of a pair of the ærial insulators and a lead-in insulator as described above has been found quite efficient in maintaining the insulation of an outdoor antenna at a very high level without any appreciable diurnal or seasonal variations.

It may be added here that the insulators constructed on similar lines with sulphur and ebonite to suit the requirements of precision electrical measurements in a laboratory are found quite successful in securing a very high insulation by avoiding the troublesome surface leakage experienced in the moist atmosphere of a laboratory situated in tropics.

A Note on Hairiness in the Punjab Cottons.

By R. S. Jai Chand Luthra.
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IN the Punjab, the aim for improvement of cottons has been the introduction of strains with lint of better quality and longer staple than the indigenous types. For this purpose greater attention was devoted to American cottons and a large number of them were put down for trial. After some experience of these varieties, it was realised that those with glabrous leaves got severely attacked by insects. Examination of the surface of leaves of a number of American cotton selections and indigenous types showed a marked difference in the extent of their hairiness and texture. Such variations among other causes were believed to be responsible for the difference in the degree of injury done by insects.

In this note, some observations made on the following points are presented :—

(*a*) Forms of hairs and their length.

(*b*) Intensity of hairiness.

(*c*) Thickness of leaves.

(*a*) *Forms of hairs and their length.*—There are two kinds of hairs found on the leaves of cottons, *viz.*, (i) branched, and (ii) unbranched. They are all unicellular. They lie on the sufrace and are closely pressed together in a tangled mass forming a loose felt-like covering. This is particularly noticeable in indigenous cottons. The branched hairs are of stellate form with rays varying from 2–8. In cetrain cases branches proceed in one direction only and form a tuft (Fig. 1).

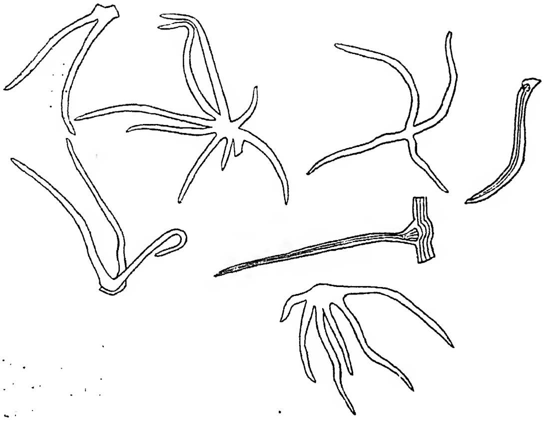

Fig. 1.

Forms of Hairs on Leaves of the Cotton Plant. (Diagrammatic.)

Length of hairs.—Small pieces of epidermis were peeled off full-grown leaves from various parts of the lamina and the length of hundred hairs, taken from different portions was measured with an Ocular micrometer under low power.

TABLE I.

Length of hairs in m.m. (average of 100 hairs) in different American and Desi varieties of cotton.

	Type	Upper surface	Lower surface
Punjab American types	1	1·07	·97
	4-F	1·07	1·05
	4-F(S)	1·13	1·03
	6	1·15	1·09
	35	1·09	1·01
	38	1·23	1·03
	19	1·15	1·03
Indigenous types	*G. Indicum*	·97	·92
	Mollisoni	·93	·89

(*b*) *Intensity of hairiness.*—Hairs present on the upper and lower surfaces of full-sized leaves of important American cotton types and also on some *Desi* varieties were examined and counted under a low power objective No. 3. The data given in Table II are averages of counts made on ten leaves and are expressed on one square centimetre area.

The table shows that there is a great range of variation in the hairiness in the American cottons. Types 1,43,4-F and

TABLE II.

Number of hair per sq. cm. in different types of American and Desi cottons.

	Upper surface		Lower surface
	Type	Average	Average
Punjab American types	1	660 ± 12·8	652 ± 167
	43	549 ± 10·5	733 ± 15·0
	4-F	600 ± 23·7	558 ± 22·1
	4-F(S)	545 ± 14·0	547 ± 15·2
	35	221 ± 16·3	331 ± 20·8
	38	231 ± 15·3	238 ± 16·4
	6	455 ± 18·6	515 ± 19·6
	19	220 ± 15·6	178 ± 11·0
Indegenous types	*G. Indicum* proper	1051 ± 21·8	993 ± 17·6
	G. Indicum Mollisoni var.	1365 ± 18·8	1253 ± 20·6

4-F (S) are more hairy than the rest. The *Desi* cottons bear 50–100% more hair than American cottons.

(*c*) *Thickness of leaves.*—Another character of importance is the thickness of leaves.

TABLE III.

Showing the thickness of leaves of a few selected types (measurements were made on ten leaves in each case).

Type	Thickness of the leaf in microns
1	296 ± 25·1
4-(F)	281 ± 24·0
38	255 ± 33·4
43	272 ± 31·8
Mollisoni	178 ± 16·0

A comparison of Tables I and III would show that American types have thicker but less hairy leaves than indigenous cottons grown in the Punjab.

1. Afzal, M., *Ind. Jour. Agric. Sci.*, 1936, **6**, Part III.

2. Berger, E. W., *University Florida, Agri. Expt. Bull.*, 1910, No. 103.

3. Husain, M. Afzal, *Agric. Jour. Ind.*, Nov. 1930, **25**.

4. Roberts W., *Agric. Jour. Ind.*, March 1929, **24**.

5. Youngman, W., and Pande, S. S., *Ann. Bot.*, Oct. 1929, **43**.

6. Solereder, H., *Systematic Anatomy of the Dicotyldons* 1908, **2**.

7. Kerner and Oliver, *The Natural History of Plants*, 1894, **1**,

REVIEWS.

Men of Mathematics. The Lives and Achievements of the Great Mathematicians from Zeno to Poincare. By Dr. Eric T. Bell. (Simon and Schuster, New York), 1937. Pp. xxi + 592. Price $ 5·00.

This book belongs to the interesting series of works like *Men of Arts*, *The Story of Philosophy* and *Green Laurels* published by Messrs. Simon and Schuster, and forms a worthy contribution to "the conscious adventure of humanising knowledge". Professor Eric Bell has, with conspicuous success, accomplished a great and worthy task for which he is eminently fitted, and this work will always remain as one of the finest biographical treatises published in recent years. Primarily this is addressed to the general reader who may desire to discover what sort of men the mathematicians were who built up the modern science, and it is bound to have a deeper interest to those who profess this science. In selecting the lives of twenty-nine mathematicians, Prof. Bell was mainly guided by two considerations, *viz.*, the significance and influence of one's work on the development of modern mathematics, and the intense human appeal which one's life and character make to the reading public. The book is not a treatise on mathematics, but its interest lies in the story of the lives and personalities of the great creators of modern mathematics, who frequently lived strange lives as soldiers, theologians, diplomats, lawyers, mystics, drunkards and charlatans. Human character acquires a charm and attractiveness through its unconscious foibles, and great men through ages would seem to have suffered from endearing frailties.

It is almost impossible to deal with the lives of mathematicians without special reference to their ideas and contributions, and Prof. Bell has made it so easy for the general reader, equipped with no more than a modest measure of mathematical training, to follow such topics as "Groups", "Space of many dimensions", "Non-Euclidean Geometry" and "Symbolic logic". Other topics in which the general reader is likely to be interested in following the contemporary scientific thought are, the doctrine of the infinite, imaginary members, the mathematics of general relativity and the theory of probability; and these subjects are treated for the benefit of the general reader, with an emphasis on their importance on modern thought.

The historical development of mathematics may be traced through four distinct phases, *viz.*, the Babylonian, the Greek, the Newtonian and the Recent. Two great advances, *viz.*, analytic geometry and the calculus gave great impetus to the growth of modern mathematics. Though Prof. Bell does not attempt anything in the nature of chronological development of mathematical science, he has kept the evolution of great ideas and abstract concepts which underlie its progress in the foreground of the treatment of the lives of their authors. The fundamental fact about mathematical science is that the ideas and inventions which were formulated tens of centuries ago, still maintain their influence and importance in modern work. It is hardly conceivable to form an estimate of what modern mathematics has achieved as compared to ancient, and even considering the mere bulk, the volume from 1800 would, it is supposed, cover 20 times the size of Moritz Cantor's *Geschichte de Mathematik*. The nineteenth century is the Golden Age of mathematics.

Commencing in the first chapter with Zeno, whose paradoxes puzzled the philosophers of ancient Athens, Eudoxus and Archimedes, the greatest scientist of antiquity, Prof. Bell treats of Descartes in the next chapter. The succeeding chapters deal with Fermat, Pascal Newton, Leibniz. The Bernoullis, Euler, Lagrange, Laplace, Monge and Fourier, Poncelet, Gauss, Cauchy, Lobatchewsky, Abel, Jacobi, Hamilton, Galois, Sylvester and Cayley, Weierstrass, Boole, Hermite, Kronecker Riemann, Kummer and Didekind, Poincaré and Cantor. A more judicious selection of great masters could not have been made, and each chapter presents a warm and vivid picture of the life and labours of these great men, portrayed with a wealth of colour and a mass of detail true to the originals.

The science of mathermatics underlies and embraces all branches of knowledge, whose progress is determined and whose

conclusions are rendered precise by the extent to which the results of investigations become capable of being mathematically expressed. Few who have followed the rise and expansion of scientific knowledge within recent times, will fail to appreciate Galileo's saying that "Nature's Great Book is written in mathematical symbols".

The book is a veritable mine of information, as important as fascinating. The author treats of ideas with the same ease and sympathy as he treats of their originators. The essence of the book lies in the personalities of the great creators of modern mathematics, and every one interested in the progress of great scientific developments either in the theoretical or applied branches of knowledge, will welcome this important work which considered even as a literary contribution is entitled to unstinted praise. The illustrations are excellent.

Comets, Their Nature, Origin and Place in the Science of Astronomy. By Mary Proctor and Dr. A. C. D. Crommelin. (The Technical Press, Ltd., London), 1937. Pp. 203. Price 8*s*. 6*d*. net.

This interesting book must be a welcome addition to the large number of works on the subject of Comets. These Heavenly apparitions when they appear fill men's minds with fear and wonder. To the astronomer they offer interesting and perplexing problems, regarding their origin, motion and behaviour. The first chapter discusses briefly the theories concerning the origin of comets, and refers to the comet families of the giant planets. Spectroscopic evidence and the fact that comets are under the influence of gravitational force tracing elliptical orbits, favour their solar origin, but it is also possible to consider that they had their birth in the same common cosmic material out of which the solar system has grown. But the final answer can hardly be presumed to have been given by Science. The large planets such as Jupiter, Saturn and Neptune have quite a number of comets attached to them, and possibly the planets themselves may have been their parents. The existence of planets forming planetary families can scarcely be explained without assuming the ejection from these giant bodies of masses of matter akin to those thrown off from the surface of the Sun during periods of eruption. The first chapter concludes with an interesting history of the Grigg-Skjellerup Comet, one of the late additions to the Jupiter family. The most interesting fact about this comet is its shortest period of any known comet, with the exception of Encke's.

Three chapters out of eight in the book are devoted to the consideration of the work and results obtained by the famous "Comet Hunters" such as Louis Jean Pous, John Russell Hind, John Tebbutt, William Frederick Denning, William Reid and Alexander Forbes-Irvine Forbes whose pioneer labours, which, apart from the romantic element attached to them, laid the foundation of the scientific study of these mysterious and elusive Heavenly bodies.

The story of Halley's Comet which is dealt with in two chapters, has a special appeal both from the historical standpoint and from the fact that it has enabled astronomers to trace the path of comets in general. This comet appeared in 1910, first as morning and later as evening star, and those who observed this visitant can never forget that among the splendours of the Heavens, there was nothing to surpass this in its baleful magnificence. The bright comet which was seen both in Greece and in China in 467 B.C., of which there is no clear account, was probably Halley's Comet, which was due about that year, and its next appearance, according to the list of its returns, is about February 1986.

In the last chapter there is a full discussion of the "Capture Theory" whose untenability was first shown by Richard A. Proctor.

For the benefit of non-technical readers there are short notes on Ellipse and Elliptical motion of Heavenly bodies, how a comet's orbit is deduced from observations and hints for amateurs interested in the search for new comets. There are good diagrams illustrating the orbital motion, together with the relative position of certain well-known comets to the constellations. The frontispiece is an excellent reproduction of Halley's Comet photographed by Professor E. E. Barnard on 4th May 1910.

The story of the Heavens always fascinates human imagination, whether cultivated or ignorant, and this book is a romantic chapter in that glittering story. The

general reader will find in it both romance and Science.

The Wandering Spirit, A Study of Human Migration. By Ragnar Numelin, Ph.D., with a Foreword by Dr. Edward Westermarck. (Macmillian & Co., Ltd., London), 1937. Pp. xvi + 375. Price 20*s.* net.

Students of Social Anthropology will welcome this book as a solid contribution to their science. The book also holds a great interest for the general reader. It presents a general analysis of the leading causes which have governed the large-scale movements of peoples in the earlier stages of civilisation, and has attempted to bring within the compass of a single book, information scattered through an extensive range of literature. Reference to literature covers 45 pages of the book, and the researches of the author have led him not into the fields of philosophical speculation, but to formulation of a sociological explanation of the factors involved in determining human wanderings. His studies of the present-day savages in whom the primitive instincts and impulses might be found in the most natural state, occupy the greater part of the book, and the author deduces from such studies the general reasons underlying migrations. He points out that although the original causes which impelled the primitive groups to vagabondage, have ceased to exist, still the spirit of wandering has become second nature to people such as the gypsies, to whom the author has devoted an interesting chapter.

The wandering instinct in man is part of his animal inheritance, and it occurs in a strongly typical form in those primitive groups who have remained in the most natural state. This spirit is controlled in human communities practically by the same factors which govern and regulate the large-scale migrations of animals—*viz.*, "subsistence—geographical reasons". As civilisation progresses and the conditions of social life become stabilised by economic and political relations, this instinct undergoes gradual transformation, and until finally it is rendered subconscious. The consolidation of human societies implies the elimination of natural forces which operate almost in an unrestrained fashion among the ruder forms of communities. Primitive human groups are exposed to the vicissitudes of the natural conditions of existence, not widely different from those under which animals live, and therefore they must be subject to the same impulses which move the lower animals to seek readjustment and adaptation to environmental factors.

The object of the author in investigating the problem of the wanderings is not to reach a definite solution, but to examine the several hypotheses with a view to test their validity, and in doing so, he has formulated certain general conclusions regarding the wanderings of peoples, their secondary manifestations and complicated cases of migrations. It is pointed out that the migrations of primitive people are movements without any definite aim and are guided by the wandering spirit which is part of their nature, while the migratory movements of civilised man are governed more fully by well-defined ultimate considerations of welfare. As the great movements of the primitive tribes took place in early historical times, when no one was at hand to investigate their causes, it must be a matter of speculation as to the reasons underlying those mass migrations. Generally speaking, the causes which lead to migrations of societies of people whatever may be their state of civilisation, are abundance or absence of food and sudden and wide changes of climatic conditions, periodic occurrences of disastrous floods, earthquakes and similar manifestations, repeated appearance of pestilence, insect plagues, tribal incursions and inability to repel them, better attractions and advantages of neighbouring districts, offering a more generous supply of food, greater security and protection of the young and the defenceless members of the community and mitigation of the rigour of climate. In the case of civilised communities, there are other factors such as, expansion of trade and commerce, extension of the sphere of political influence, scientific explorations, and above all the desire and tendency for spreading the blessings of civilisation and Christianity among the heathens, which have led to migrations, peaceful penetration, and final absorption of foreign territories. To a large extent, the power that science has conferred on civilised man to control the influence of nature, has altered the conditions of survival in the struggle for existence, such as operate among the primitive societies, and at the same time it has

placed in the hands of modern man the means of destroying civilisation.

We agree with the author that the primary cause which impelled the primitive man to move from his temporary settlement must be the subsistence—geographical factor, to which may be added the spirit of curiosity and exploration inherent in man, irrespective of his scale of civilisation. The natural forces being brought under scientific control, modern man is solely guided by the spirit of adventure, stern economic necessity and restlessness to use his powers against defenceless people in his wanderings or in his quest of new lands for colonisation.

The migratory movements of lower animals are not strictly analogous to those of the primitive tribes of mankind, although the causes which impel both may not be widely different. The lower animals after their seasonal journeys, however long, always return to the place from which they started. This is true of several groups of animals. But primitive man when once he left his old home, ceased to think of returning to it, unless the new one proved undesirable and inhospitable. Animals seem to preserve the homing instinct while it was probably absent in primitive man, unless the old home had irresistible attractions for him.

The nomadic habits of certain tribes such as the gypsies are capable of a different explanation. Civil strife, overpopulation, unsettled condition of public life offering opportunities for the practice of criminal propensities, and the prospect of driving petty trade or playing on the credulity of unsuspecting people for personal profit, must have been the basis of the roaming spirit of all the nomadic people. Lust of unlawful gain and anti-social proclivities underlie tribal movements, and in the course of a few generations the habit of roaming about becomes ingrained in these people as an instinct.

It is almost impossible to give in the course of a review an idea of the range and variety of the enquiry pursued by the author and the very interesting results summarised by him in the book. The book throws fresh light on some of the obscure problems of the great movements of peoples in the infancy of civilisation, affording material for arriving at a correct estimate of the kindred problems of racial and cultural affinities. This volume is a critical summary of a whole library of books, and it is at once illuminating and stimulating.

Milk, The Most Perfect Food. By Prof. Dr. N. N. Godbole, Benares Hindu University, with a Foreword by Pandit Madan Mohan Malaviya. 1936. Pp. xvii + 137. Price Rs. 3, foreign 6*s*. inclusive of postage.

This is an excellent treatise, worthy to be in every household. Prof. Godbole has approached his task in a scientific spirit and in the performance of it he displays the commendable zeal of the convinced advocate of the principles he wishes to propagate. Besides references to the value of milk as an article of diet in the ancient Hindu literature, he deals with every aspect of this product in a simple and direct way. There are interesting chapters on allied topics such as Tea and Coffee and there are others devoted to a brief consideration of alcoholic beverages. A separate chapter is given to the examination of the relative value of vegetarian and non-vegetarian diet, and the last chapter provides comparative tables of food values. The chief merit of the book is the simple and honest way in which it treats the subject, and the author wishes India to go back to her ancient milk-mindedness, which seems almost to underlie her culture and civilisation.

A modern reader of the book is likely to be assailed by certain doubts, which perhaps he might put in an interrogative form and, presumably the author must have answers to such doubting Thomases.

Is there a Sanskrit saying which places man on a level with animals in respect of "food, sleep and procreation"? If it does, do adult animals use milk as an article of food? Are there people who have never touched milk in their adult life, and who, however, are strong, healthy and enduring?

"*Ahimsa*" is "*Parama Dharma*". Well, do vegetables have life? Do they suffer when they are cut and cooked?

Is protoplasm meat? Is there protoplasm in the vegetable tissues? If so, does this differ from the protoplasm of animal tissues? Is there a Sanskrit saying meaning, 'life subsists on life?'

Did the Aryans who gave the world *Vedas* and laid the foundation of *Dharma*

Sastras, eat meat and drink wine? What does the chapter on food in *Manu Dharma Sastra* say in the matter of flesh diet? Is it ethically justifiable to rob the cow of her milk, intended by her Creator for the exclusive use of her calf, and will it not involve "*Himsa*" both to the mother and her offspring?

These questions and sundry others of a similar character might appear ridiculous and impractical, but when one becomes dogmatic and even meticulous in laying down canons in the prescription of articles of diet, supported by scriptural authorities, then one is bound to encounter with such questions. The problem of food is essentially a matter of racial prejudice, and predilection and the choice of its articles is governed largely by traditional habits and instincts. Departure from such habits is almost entirely due not to perversion but to the innate tendency to reversion to more primitive tastes, stimulated by modern chemical discoveries.

The Clear Mirror (A Pattern of Life in Goa and Indian Tibet). By G. Evelyn Hutchinson. (Cambridge University Press), 1936. Pp. 171 and Plates XIII. Price 8*sh.* 6*d.*

This quaint little travel book is an account of the religion, art and natural history of the places visited by the Yale North Indian Expedition in 1932. Mr. Hutchinson who went as the biologist of this Expedition has attempted not only to describe in detail all that he saw and experienced, but also to give in the course of the composition some thought-provoking digressions so essential for a profitable travel narrative.

At first the focus is the mediæval Portuguese Settlement of Goa on the West Coast of India, and afterwards the bleak semi-desert of Indian Tibet. The description which derives its main substance from the religious and artistic culture of the inhabitants of these places combines in lucid style the natural history of the terrain and in consequence the text is not without scientific and literary value. Buddhism which flourishes with a predominant following in Indian Tibet, where Islam is struggling for a bare existence with a few adherents, is a rich store-house of ritual and ancient customs. Numerous instances are to be found in the book where the more important of the Buddhist religious rites are recorded in intimate detail which make highly interesting reading. An amusing superstition current in the Chang-Chenno District of Indian Tibet is about the *Pantholops*, the peculiar Tibetan antelope. This animal which is confused with the legendary unicorn, as the beast appears in profile to have but one horn, is reputed to be so delighted at the sight of a virgin that it comes and puts its nose in her lap. In this way the animal could be easily caught.

The book, which is rich with the fruits of a successful expedition into lands of which little is known to the lay reader, comprises all the elements derived from art, religion and natural history of the places visited and preserves alike those "mind-disturbing" qualities characteristic of great travel books.

C. N. R. Rau.

Television, A Guide for the Amateur. By S. A. Moseley and H. McKay. (Oxford University Press), 1936. Pp. 144 with 50 figures and 31 plates. Price 5*sh.* net.

In Europe and North America, the first steps towards achieving a national television service have already been inaugurated. To the ordinary person, the mystery of the scientific laboratory of yesterday has assumed at present the glamour of novelty. And beforelong, the novelty will no doubt wear off, and a television service will be taken as much for granted as sound broadcasting is at present. Interest in television is no longer confined to the scientist and the engineer; the mass of the people share it.

This book is therefore appropriately designed for the general reader with little technical knowledge. In the twelve chapters covering a little less than 150 pages, the essential elements of the theory and practical apparatus of television are described briefly in simple, straightforward terms. The first chapter on the scanning of a picture is followed by a discussion of the mechanical and electronic methods of scanning; by the use of the scanning disc and mirror drum on the one side, and the ingenious iconoscope of Zworykin and the dissector and multiplier of Farnsworth.

Television reception takes up the greater part of the book. The cathode-ray tube is described in considerable detail, including electron optics, time bases, etc. The difficulties of light control and of producing

pictures of the size of a cinema screen are explained clearly. The use of hyperaudio frequency waves travelling in liquids is a highly original and most ingenious method due to Jeffree. The description of mechanical methods of reception refer to the Scophony mirror-screw and the Mihaly-Traub devices and the modifications in them. The last chapter deals very briefly with the two television transmitters in London, the Baird and the Marconi—EMI. The book closes with a few useful pages of brief explanations or definitions of the terms used in television.

There are 31 beautifully reproduced photographic plates, a number of line diagrams and no mathematics. The language is simple and the descriptions accurate. The printing is excellent and free from errors. On page 81, line 6, *contol* should obviously be *control*.

RE

Elements of Electricity. By W. H. Timbie. Third Edition. (John Wiley & Sons, Inc.), 1937. Pp. x + 569. Price 15 *sh.*

The book is intended for technical students and is designed to give them a clear grasp of the principles governing the working of electrical machines and the simpler calculations needed in understanding quantitative relationships in their design and working. It is not a purely technical treatise in the sense of dealing with details of technical design. In writing the book, a certain amount of preliminary knowledge of first principles of electricity and magnetism seems to be anticipated. The quantitative treatment is elaborate and richly illustrated at every step by examples worked out and problems set. This must be considered a special and valuable feature of the book. Calculus methods are rigidly avoided, though it sometimes results in a little circumlocution as in the treatment of inductance and the theory of alternating current circuits. Since the lower grades of technical students could scarcely be expected to carry their studies to the standard adopted in the book, this omission was not really necessary, and the kind of students who could profitably use this book, would have easily understood the elements of calculus that might have been employed usefully. This is the more so, as the mathematical treatment including the use of trigonometric functions and graphical and vector methods, is fairly elaborate. However, this point need not be unduly emphasised.

The treatment covers the most essential points of interest to an electrical engineer, such as the properties of electric, magnetic and electrostatic circuits and of the materials employed in such circuits, the construction and action of different types of generators and motors, power transmission problems, alternating current circuits embracing inductive and capacitive reactances, storage batteries, etc. The chapter devoted to thermionic phenomena including thermionic valves and their uses, X-ray tubes, gaseous rectifiers, and photoelectric effects will no doubt be found very useful by electrical engineers working under present-day conditions. The treatment of the different subjects is greatly assisted by a wealth of diagrams, figures and graphs. A noteworthy point is the attention devoted to clear definitions of units, emphasised by examples in their use. One misses a description of the construction and working of an important class of instruments, the measuring instruments such as ammeters, voltmeters, etc., though their use is indicated from the first chapter onwards. The answers to problems are given in a separate booklet. The printing and get-up is very good and there are practically no errors or misprints.

On the whole there is no doubt that the book will be of great use to students of electrical engineering. The standard may not be high enough for those undergoing a degree course, but the book offers a very clear grasp of first principles even to them.

A. Venkata Rao Telang.

Radioactivité. par Mme. Pierre Curie. (Hermann et Cie., Paris), 1935. Pp. 563; 170 figures and 26 plates. Price 150 *fr.* (Paper covers).

This is an exposition of the lectures delivered by Mme. Curie at the Sorbonne for a number of years, during the course of which the treatment has been continually modified to take the progress of the science into account. The book is divided into two parts. The First Part occupying 125 pages deals with the various investigations that have led to our knowledge of atomic structure such as ionisation of gases, properties of gaseous ions, cathode rays, positive rays, X-rays and the theory of quanta. With

this well provided background, the Second Part plunges into a detailed treatment of the subject of Radioactivity. Here we have a detailed description of the various radioactive families, and the radiations emitted by them. Induced radioactivity and nuclear transformations find their natural place as organic parts of the whole subject. Being a treatise intended for students, subjects, which are not yet fully developed and contain controversial results, such as nuclear structure, are not treated. For the same reason references to original papers are not given, but books for consultation are mentioned and the various results are described with references to their authors and the history of their development. The treatment is mainly experimental. Elements of the necessary theory are given, but even in such a case as the scattering of α-particles the steps are only sketched and the details of the mathematics are not developed, while in the case of Gamow's theory of the emission of α-particles, or the Klein-Nishina formula for the scattering of γ-rays, even the bare outlines of the reasoning are not described. As can only be expected from the authorship, the description of the experimental side is masterly and in each page we meet with remarks to which an investigator in the field would be ever grateful for their help in removing some perplexing difficulty in his path. The tables at the end of the book would also be eagerly welcomed by workers in the subject. One strong and admirable feature of the book is the wealth of illustration, most of the plates being models of clarity and beauty. They should serve also as examples of the perfection of technique to be aimed at by a student of the subject. In most cases the figures have legends attached which serve to describe the whole experimental technique. Sometimes this is all that is given: such is particularly the case when the author is dealing with some interesting side topic not directly connected with the main theme. There are a number of such interesting glimpses into other important branches of study, *e.g.*, the Coolidge X-ray tube, the triode valve, Hertz's apparatus for determining ionisation and excitation potentials and so on. In a very few cases modern results are not quoted but earlier investigations are mentioned. For example, in the separation of isotopes, Hevesey's older investigations are mentioned but the successful separation of isotopes by Hertz is not referred to. Aston's older form of mass-spectrograph is described, but not the improved form. It is a pity that such an extensive book should not have an index. The book has only paper covers as is the usual French practice. We have noticed a few misprints here and there, but the printing is, on the whole, good. Taking a view of the book as a whole we find that the First Part deals with subjects on which we have excellent English books, but the mastery and individuality displayed in the Second Part make the book unique. We heartily recommend it to all students of the subject. Those who intend to embark on original investigation in the field ought to digest the whole of this masterly exposition.

T. S. S.

A Text-Book of Physical Chemistry. By S. J. Smith. (Published by Macmillan & Co., Ltd.), 1936. Pp. 354. Price 5*s*. 6*d*.

This book would serve admirably as a text-book of physical chemistry for the B.Sc. (pass) students of Indian Universities.

In the Preface, the author has rightly pointed out that recent advances in physical chemistry "demand an extreme tolerance of new hypotheses and a restrained scepticism of what have been regarded as almost undisputed theories" and by tracing the historical development of certain topics he has indicated not only the utility and scope but also "the limitations and arbitrariness of both theories and definitions".

Attention may be drawn to the following commendable features of the book. The principles underlying the determination of atomic weights have been clearly stated. Treatment of optical activity and the principle on which the polarimeter is based is good. As stated in the Preface "those branches of physical chemistry which have important technical applications—for example colloids, catalysis—have been discussed irrespective of examination requirements". The industrial applications of catalysis—notably hydrogenation of oils and of coal—have been thoroughly dealt with. Other topics that have received adequate attention are the electronic theory of valency, dipole moments, electrode potentials and the theory of indicators. A number of problems have been worked out in the text and

students as well as teachers would no doubt welcome the carefully selected questions at the end of each chapter.

When an attempt is made to deal adequately with the topics discussed, it is but inevitable that certain other topics should be crowded out of a book of moderate size. All the same one is rather disappointed to find in the book no mention of the liquefaction of gases or of freezing mixtures, or of the effect of a third substance on the critical solution temperature of two liquids.

Certain inaccuracies have crept into the text and there are also some noteworthy omissions. On p. 225 the complex copper ammonium ion is indicated with two negative charges. It is hardly correct to assign to a jelly of gelatin a honeycomb structure (p. 157). On p. 298 in describing the calomel electrode no mention is at all made of the paste of calomel with which the mercury in the electrode is covered. It is difficult to maintain that chamber crystals constitute the intermediate compound in the production of sulphuric acid by the chamber process. On page 309 it is desirable to state that for moderate concentrations of a catalyst, the increase in velocity of the reaction is directly proportional to the mass of catalyst employed ; for, the average student is likely to carry away the impression that a mere trace of catalyst need be employed in actual practice to secure adequate increase in the velocity of a chemical reaction. It is doubtful if the comparative stability of lyophilic colloids towards electrolytes (p. 162) can be correctly accounted for by stating that the large number of water molecules (associated with the colloids) "exert a stabilising influence by preventing the near approach of the precipitating ions ". On p. 287 the diagram of the dropping mercury electrode is inaccurate. For successful work it is very necessary that the mercury stream should break into spray just below the surface of the solution. The mechanism of negative catalysis given on p. 318 is not the only one that can account for the phenomenon.

In spite of these minor blemishes the book is very suitable as a text. It is moderately priced and can heartily be recommended.

B. S. Rao.

Recent Advances in Cytology. By Dr. C. D. Darlington. Second Edition. (J. & A. Churchill, London), 1937. Pp. 670.

Modern cytology has progressed very considerably in the brief space of five years since the publication of *Recent Advances in Cytology* by Dr. C. D. Darlington. The Second Edition of this valuable book will, therefore, be welcomed by every student and research worker, who wishes to keep in touch with the latest developments in the study of nuclear mechanism, especially with those aspects of it that have a direct bearing on genetics. "It is perfectly possible that *Recent Advances in Cytology* marks a turning point in the history of Biology," says Prof. J. B. S. Haldane in his Foreward to the book. Coming from Prof. Haldane, this remark is very significant.

Cytology, which until recently was chiefly interested in the description and enumeration of simple observations, has principally by the stimulus given to it by Dr. Darlington, developed into an almost exact science wherein each cell process is shown to be connected with every other cell process and their causation shown to be due to the working of forces which are identical in animal and plant tissue.

That meiosis is an abnormality of mitosis and the origin of sexual reproduction was shown by Dr. Darlington in the First Edition of his book. In the Second Edition he has recast the whole account of chromosome behaviour in terms of Evolution and presented further evidence to show that uniform behaviour of nuclei make deduction and predition possible. Special emphasis is also laid in this edition to Cell Mechanics to which the last and longest of the 12 chapters of the book is devoted. In this chapter Dr. Darlington shows clearly how the laws of movement of chromosomes are explainable from the mechanical point of view. In many respects this is the most important chapter of the book.

The Glossary and Bibliography presented in the book adds much to its value as a ready reference not only to all research workers engaged in cytology and genetics, but such university teachers who wish to keep their teaching in pace with the rapid advance made by biological science to-day.

The book is excellently illustrated with 16 plates, 160 text-figures and 81 tables, which present the most recent findings in the field of modern cytology.

The Indian Zoological Memoirs—VI. *Palaemon*. By S. S. Patwardhan, D.Sc. (Lucknow Publishing House, Lucknow). 1936. Pp. xi + 100. Price Rs. 2.

The sixth volume in the series of Indian Zoological Memoirs deals with the Indian river prawn *Palæmon*. In the introduction some of the important characters of the class Crustacea are enumerated with special reference to the Decapoda. The systematic position of *Palæmon* is briefly indicated and a key (after Kemp) is included to distinguish the three genera of the sub-family to which this prawn belongs. The systematic part might have been dealt with perhaps in a little more detail and the species of *Palæmon*, which forms the basis of the memoir should have been definitely stated. From the foot-note on p. viii and from one or two other scattered references in the text one presumes that the species dealt with is *P. malcolmsonii* but it would have been useful if the author had definitely stated whether the account refers to this particular species or is, so to say, a composite picture of a member of species.

The external characters, the appendages, the integument, the endophragmal skeleton and the various systems of the body are all described in great detail and a short chapter on bionomics and distribution is also included. A useful chapter on directions for practical work ends the work. Reproduction and embryology have not been dealt with.

The illustrations, which are mostly original, are very well done. These are useful in explaining the different structures, but it would have helped the reader more if the explanatory reference letters had been mentioned in the text also.

Only a very few of the important references are given as foot-notes; it would have been an advantage perhaps if a short Bibliography had been included at the end.

The memoir is very well got up and is on the whole free from misprints. Both the author and the editor are to be congratulated on the production of this fine work, which will undoubtedly be of very great use both to the students and the teachers.

Dr. Bahl, the Editor of the series, deserves the thanks of all Indian zoologists for maintaining the high standard of these memoirs. His recent donation of Rs. 700 towards the cost of publication of the series, to which reference is made in the Editor's preface, is only another instance of the great interest that he takes in this work.

B. N. C.

A Practical Course in Agricultural Chemistry. By Frank Knowles and J. Elphin Watkin. (Macmillan & Co., Ltd.), 1937. Pp. ix + 188. Price 10*sh*.

This book achieves fairly well what the authors set before themselves to accomplish—a practical text-book of a practical course in agricultural chemistry. Well-known, standardised and accepted methods are fully and well described, in such a manner as to leave no doubt in the mind of the student. People working in different fields of agricultural chemistry may regret the omission of this or that method, but viewed as a whole and from the point of view of the student working up for an examination the choice of methods has been usefully selective. This book can be safely recommended for guidance for all students to whom the field of agricultural chemistry is new.

N. G. C.

Calcutta Geographical Review. Vol. I, No. 1. (Published by the Calcutta Geographical Society), September 1936. Annual Subscription Rs. 3–8–0.

It is well known that in Western countries, those in charge of the education of the young, have all along realised the great educative and cultural value of a proper study of Geography, and have therefore not only included this subject in the secondary schools, but have also provided for graduate and post-graduate courses in the university. In India, we have for long been suffering from antiquated and mistaken notions of the meaning and scope of this subject, with the result that Geography is to-day the most despised and the worst treated member in the family of subjects claiming a place in the curriculum of schools and colleges in India. It is, however, gratifying to find within recent years, that educationists all over India have begun to realise that they are making a great mistake in thus neglecting the study of Geography, and are striving to find for it an honoured place in their reorganised courses of studies. The neglect of Geography in the past has been largely responsible for the making of poor citizens, with a narrow and mean outlook on life. In

the words of Prof. Atwood of Clark University in his Presidential Address to the National Council of Geography Teachers. "There never was a time in the history of the world, when a study of the various people of the world, and the geographical condition influencing their lives, directing their plans as they seek for means of existence, should be taught so thoroughly as to-day. The responsibility is before us. I submit that there is no subject in the school curriculum that so naturally and so necessarily deals with the large world-wide problems of to-day as Geography. There is no subject in the school curriculum that can so appropriately deal with the actual living conditions in the different parts of the world of the present time." The general public in India have to be rapidly educated to appreciate the importance of the subject of Geography, and in this endeavour, the Madras Geographical Association gave the lead several years ago. We are glad to note that a similar society has recently been organised in Calcutta for the promotion and spread of geographical knowledge, and it is with sincere pleasure that we welcome the first number of their *Geographical Review*. The society has been fortunate in enlisting the sympathy and support of a number of distinguished and influential men in Bengal, and the Journal is conducted by a thoroughly competent Editorial Board, presided over by the well-known Indian geologist and geographer, Mr. D. N. Wadia of the Geological Survey of India. The first number of the Journal which is now before us contains several very interesting articles written by men with first-hand knowledge of the subjects they are dealing with. The place of honour is given to an article by Dr. A. M. Heron (Director, G. S. I.) on "The Everest Neighbourhood" in which he gives a lucid account of the main geological and geographical features of this neighbourhood, including a vivid pen picture of life in a typical Tibetan village. In their article on "Glimpses of Burma and the Shan Hinterland," Dr. M. R. Sahni and Mrs. Shyama Sahni have given us a wonderful account of this part of the country and its people—an account which is as fascinating as it is informing. In "The Story of a Stone", Mr. D. N. Wadia makes the 'stone' speak for itself, and it succeeds in giving us several fundamental lessons in Geology, all the while keeping us absorbed in its autobiography. After reading this, who can deny the fact that there are truly "sermons in stones?" Many of the articles in the Journal bring out in a striking manner the intimate and inseparable relationship between Geography and Geology; in fact, no geographical studies of the right kind are ever possible without a suitable geological background. We wish the Journal a long and prosperous career of ever increasing usefulness.

L. Rama Rao.

Nature Study Reader for Fourth Year Pupils. By Phyllis S. Darling, M.R.S.T., F.R.S.G. (Oxford University Press), 1936. Pp. 62. Price As. 10.

This little book maintains the high standard established by the previous publications on the same subject for lower class pupils, and contains a graduated series of twenty-seven lessons. We congratulate the author on producing these excellent interesting little books on the important series of topics, calculated to train the eye and the hand, and to stimulate the spirit of curiosity. The book is written in simple English and should offer no difficulty either in teaching or learning.

The chapter on stars might offer some difficulty in understanding or identifying the different constallations, because the vernacular equivalents are not given. This chapter might have been rendered more interesting and useful if some reference to the appearance and the relative position of some of the bright planets, had been included. For instance, the conjunction of Venus, Jupiter and the Moon at certain months of the year is one of the most conspicuous phenomena of the Heavenly bodies, and the pupils ought to witness such conjunctions and note the time of the month in their diaries.

The topics of other chapters are carefully selected and adequately treated. Beautiful illustrations of the common tank and pond fish, sea shells and some fresh-water insect larvæ are included, and they certainly enhance the value of the book. We hope that this book will be widely used in all the schools and we doubt whether better books are in the field.

The Ice Age.

[*The Quaternary Ice Age*, by W. B. Wright. (Macmillan and Co., London), 1937. Pp. xxv + 465, with 23 Plates. Price 25*sh.* net.]

THERE are few questions connected with the geological history of our earth which has exercised the popular imagination more than the one regarding its very recent passage through a glacial period when large areas of the northern world, down to the latitude of 40° were frozen under a pall of ice-sheets and glaciers. That North Europe and America, just at the advent of Man in Europe, or contemporaneously with a few already established races in the more southern parts, were covered under vast ice-caps very much like the North and South Polar regions of to-day is one of the most satisfactorily proved events of geological history, even if science has not yet succeeded in finding a generally accepted cause, or causes, for this unique phenomenon. Indeed no section of geological history possesses a more voluminous literature or inspires a greater number of amateur investigators, and yet the mystery of the subject has deepened with the growing literature. It can perhaps be truly said that we are not nearer solution to the question of the causes of the Ice Age than when Croll propounded his famous astronomical theory in 1885, ascribing the glaciation of North Europe and America to a time when, the eccentricity of the earth's orbit being considerably greater than at the present day, the northern summers occurred in perihelion.

In the attractively got-up volume before us, the revised second edition of his book originally published in 1934, Mr. W. B. Wright of the Geological Survey of Great Britain has presented the subject in a lucid manner both for the student and the layman. He gives a clear account of the existing state of knowledge regarding the Ice Age of Europe and America, more especially in regard to its relations to man, the Quaternary mammals, and the displacements of sea-level consequent on the withdrawal of large volumes of sea-water required for the formation of ice-sheets of continental magnitude, and their restoration to the sea on the termination of the Ice Age.

The question of the interglacial ages—the four or five interludes of comparatively mild climates intervening the cycles of arctic intensity, which was rather inadequately dealt with in the last edition of the book, in conformity with the trend of thought 20 years ago, is now more exhaustively treated both for Europe in general and for the Alps.

The author's main original contribution to the subject, the so-called isokinetic theory, to account for the oscillating sea-levels during the Quaternary, as marked by the fluctuating strand-lines of the northern coasts, is given special treatment in two chapters. The isokinetic theory is a modification of the theory of Isostasy, which in essence implies that there is a certain amount of hydrostatic balance between the different segments of the earth's crust so that if an extra load is imposed on any portion of the surface it must sink under it, while the adjacent unloaded parts must rise until equilibrium is established.

The formation of an ice-sheet on land several thousand miles in extent and 3000 to 4000 feet thick, such as the one which covered Scandinavia during the Pleistocene Ice Age, must, if isostasy is perfect, have depressed the crust over that area under the extra load to the extent of as much as one-third of the thickness of the superincumbent ice. The withdrawal of so much water from the sea to form the enormous ice-caps of Fennoscandia and North America at the same time, would, according to the original estimates of Penck, have caused a world-wide lowering of the ocean level, during the height of the Ice Age, to the extent of about 300 feet. At the height of the glacial epoch, therefore, the strand-lines of the world were considerably lower than now and as the ice gradually retreated, isostatic recovery took place and not only the unloaded lands rose, but the melting ice caused the sea-level to rise once again submerging considerable areas of the land-surface and giving rise to new post-glacial shore-lines and terraces.

How far this simple hypothesis explains the complex facts of the relative displacements of land and sea and the confused story of elevated and depressed shore-lines, beaches and terraces in different parts of the world during the last geological epoch,

it is not yet possible to estimate. The researches of Swedish and Norwegian glaciologists do not lead one to conclude that some kind of isostatic balance affords the best explanation of the noteworthy relations of glacial and post-glacial changes of sea-level as reflected by the struggle between sinking land and falling sea-level at one time and rising land and rising sea at another. The theory of isostasy had its birth in India, but the brilliant work on gravity estimation carried out by the Geodetic Survey of India during the last decade and the data collected in support of the crustal warp theory by Col. Glennie are so much at variance with the hypothesis of isostasy as to lead one to doubt whether the postulates of isostasy are fundamentally correct.

The chapter on Loess, Quaternary mammals and post-Tertiary Man contain much condensed information and is of great interest; the author summarises the facts of the correlation of fossil mammalian fauna and the successive human cultures with the zonal sub-divisions of Quaternary stratigraphy of Europe in a manner that is bound to interest both the man of science and the lay reader. One serious shortcoming of the book, however, is lack of any reference to the glaciation of North Asia, the whole area of which, including Siberia, being not mentioned. While this may be due largely to the fact that no such authoritative investigation on the subject has been carried out in this region as in Europe, a brief statement of existing information on this subject and some tentative hypothesis accounting for the absence of continental ice in North Asia would have added to the interest of the book.

The volume is well illustrated with diagrams, sections, photographs and maps. A copious Bibliography accompanies each chapter and the Index covers eleven pages.

D. N. WADIA.

Biology of the Desert Locust *Schistocerca gregaria*.

THE record of Locust control work in the past in India narrates a story of expensive and troublesome operations carried out in various tracts visited by the pest and almost total indifference to the problem after it had disappeared. No systematic or concerted action regarding control of any pest is possible unless accurate data about the biology, life-cycle, habits and habitats of the pest are available. On the occasion of the last serious visitation by Locust in 1926–30 very little information about the biology of this pest in India was available. Towards the close of this visitation the Imperial Council of Agricultural Research initiated and financed an elaborate research scheme under which the pest was to be thoroughly studied both in the laboratory and the field. Mr. M. Afzal Husain was appointed Locust Research Entomologist at Lyallpur and held this appointment for about three years. The headquarters of the field staff which was under Mr. Ramachandra Rao, was first fixed at Quetta and then at Karachi with a field laboratory at Pasni on the Mekran Coast in South Baluchistan. The work done at Lyallpur on the biology and physiology of Locust is being published in a series of articles in the *Indian Journal of Agricultural Science* of which seven papers have appeared up to now (Vols. III & VI) and are the subject of this review.

Although the Desert Locust has been a periodic visitor of the extensive plains of this country it does not seem to have been able to establish itself permanently in India, except some parts of Sind, Rajputana and South Baluchistan. It is interesting to ascertain the cause of this curious behaviour. The ecological studies carried out indicate that *Schistocerca gregaria* is a tropical insect with the threshold of development at about 18°C. (about 64°F.). This means that apart from food and humidity factors, wherever the winters are severe and the temperature remains below the threshold of development of the species for a considerable period, the pest will be subjected to high mortality.

The exact number of broods of the Locust in a year was also under dispute and several workers were of the opinion that *Schistocerca gregaria* undergoes a compulsory resting period (diapause) in the adult stage, whereby the number of broods is limited to one or two in a year. It has now been shown that the life-processes of this species, like those of other insects, are intimately connected with and controlled by the environmental temperature, that it can breed within the temperature range of 25°–40°C., and that there

is no diapause in the true sense in any stage of this insect. Therefore though under natural conditions in the Punjab, the locust has only two broods in a year, under temperature conditions ranging from 37°C.–40°C. as many as 6–8 generations in a year are possible. These conclusions are of great importance and reveal the potentialities of this pest under suitable environment.

The Locust is known to have two phases: solitary and gregarious. In the solitary phase the colour of the hoppers is greenish whereas in the gregarious or swarming phase the body has a black pattern. The causes underlying the change of solitary phase into the swarming phase and *vice versa* are undoubtedly of great importance both from economic and academic points of view. The work under review indicates that it is possible to convert a *solitaria* hopper into a *gregaria* one by crowding it with other hoppers and make a *gregaria* hopper lose its black markings by breeding it isolated. Moreover it has been shown that an isolated hopper of *solitaria* nature when forced to move about for a considerable time each day and thus given exercise artificially developed the black pattern of the *gregaria* phase irrespective of crowding with which alone it was hitherto supposed to be intimately associated. Likewise an isolated *solitaria* hopper when bred in an atmosphere containing excessive carbon dioxide developed the black pattern, associated with the *gregaria* phase. It would appear from these experiments that the production of the black pigment is connected with the rate of metabolism as well as the respiratory function of the organism. Some experimental evidence has been furnished to show that hoppers of true gregarious phase exhibit intensities of black pigmentations in inverse proportion to the temperature of the environment. These observations, admittedly incomplete, have important significance on the phase theory according to which the two phases are based on the colour and morphological differences. It however, yet remains to be seen whether the morphological differences can be brought about by environmental changes or whether they are a result of association alone.

The fact that most Locust adults change their colour to yellow, at the time of sexual maturation, had given rise to impression that the extensive physiological changes that occur during the development of the genital products result in the formation of the yellow pigment. This has proved to be wrong. Males as well as females whose sex glands were removed in their last hopper stage and which on dissection at death were found not to have regenerated these glands developed the yellow colour as rapidly as the normal adults. Moreover, adults bred at comparatively low temperature matured and oviposited without ever yellowing.

It is hoped that economic entomologists will, in due course, be able to exploit the results described above to the advantage of farmers.

HEM SINGH PRUTHI.

Agricultural Research in India.

[*Scientific Reports of the Imperial Agricultural Institute, New Delhi, including the Report of the Sugarcane Expert, Coimbatore, for the year ending June 1936.*]

THE report of the Imperial Agricultural Institute, New Delhi, is the record of another year's work under the difficult conditions caused by the last disastrous eartnquake in Bihar and by the preoccupation of the staff in connection with the shifting of the Institute to Delhi. Much of the research and experimental work had to be suspended and the actual work has related only to the completion of those already on hand. Though therefore much restricted in volume, the work and results reported continue to be of much scientific and practical interest. In the Chemical Section the effect of sunlight and ultraviolet light on nitrification in soils, both acid and alkaline in reaction, was further studied and the results showed no evidence of nitrification at all. We may perhaps take it that this definitely disproves the claims made to the contrary by Prof. Dhar. The study of acid soils and their amelioration was continued and as a result the use of a mixture of calcium and sodium carbonate is advised in preference to either of them applied singly, the former incidentally being

a less expensive method in practice. Knowing the deleterious action of sodium carbonates on the physical condition of soils one is generally chary of resorting to the use of such salts, and we should, for this reason, like to see further work on the subject. Large scale experiments on green manuring with sann hemp have confirmed previous observations and show that the crop could be grown for a longer period and made use of for a double purpose, the tops for green-manuring and the stems for fibre-making and that this method is quite as good as if the whole plants were incorporated in the soil for manure.

In the section on Crops, wheat breeding occupies the pride of place the aim being chiefly to evolve types resistant to cereal rusts; a separate section was created for this work in the year and some promising crosses have already been produced and selected for further work on breeding. The older varieties of Pusa fame have continued to be popular and large quantities of seed have been supplied, in fact the demand is said to have been more than could be met by the Institute. Attention is drawn to the striking differences in the malting quality of one and the same type of barley when grown in different tracts, which one would think was only in accordance with the general belief in the influence of soil composition and manuring on 'quality' in barley. Work on potato breeding was commenced in the year and a number of Indian and Foreign varieties including varieties from Central and South America were studied; likewise a large number of seedlings were successfully raised and a good many crosses also effected. We may look forward to important results in the evolving of high-yielding and disease-resistant types, a desideratum which has seriously kept back the popularisation of this valuable food crop.

The Sugarcane Station, Coimbatore, maintained its high level of research both of practical value and scientific interest. The station was able to release for trial during the year a few types of canes combining earliness with good tonnage. The sorghum sugarcane hybrids have been, it is reported, found disappointing as regards earliness which was the characteristic about which high hopes were entertained. The problem is however to be attacked on a wider basis, we are told. The breeding of thick canes has also been attended with much success; the new types Co 419 and Co 421 have done very well, and on the Padagaon Station Co 419 gave a higher yield than the famous P.O.J. 2878. A very noteworthy result has been the production of bud sports by the simple process of bruising and damaging the eyebuds of the seed setts; we wonder if the method will succeed with a large percentage of buds and again likewise with other varieties also, which has been achieved in the variety Co 213. Cytogenetic studies which form a new feature of the work in the station established the genuineness of the sugarcane sorghum crosses about which apparently there was doubt. The development of a suitable technique in this work occupied particular attention in the year.

In the section on Plant Diseases and Pests we may specially draw attention to the study of the bionomics of the parasites of sugarcane pyrilla, as the result of which the periodical removal of the leaf-sheaths of affected cane is suggested as a measure of some relief. The work on the mosaic of sugarcane in the Mycological Section is of absorbing interest and will well repay study. This baffling disease is being examined from various angles including serological studies. The reactions and behaviour of the virus under a number of conditions are reported and the interesting observation made that the infectivity appears to be associated with chlorophyll, as filtrates remain active only as long as the green colour persists. We are led to hope that beforelong much light will be thrown on the different aspects of this difficult problem.

It is gratifying to read that the famous Pusa herd of dairy cattle has not only maintained its high standard but has even excelled past performance, the milk yield average having increased from 19·1 lbs. in the last year to 21·2 lbs. in the year under report. The herd is now being moved into its original home and it will be interesting to watch its reaction to this, its home coming after such a long period.

The chief event of the year is the transfer of the Institute to its new home in Delhi. This marks a new epoch in its history and we note that all the different sections commence work in their new sphere with greatly added facilities for research. On the threshold of this new era we offer to this great and beneficent institution our best wishes for a long career of practical usefulness and scientific distinction.

A. K. Y.

The Cape Crawfish.*

THE Cape crawfish, *Jasus lalandii* (Milne-Edwards), forms the basis of a very extensive industry in the Union of South Africa and the publication of the report by Cecil von Bonde entitled "The Reproduction, Embryology and Metamorphosis of the Cape Crawfish (*Jasus lalandii*) (Milne-Edwards) Ortmann" is, therefore, of special importance for the scientific exploitation of this industry. The present report is more or less a continuation of the work that the author did in collaboration with J. M. Marchand on the natural history and utilisation of the Cape crawfish a couple of years ago. In the present pamphlet the life-history of the crawfish from the fertilisation of the egg to practically the adult stage is described. The importance of the knowledge of reproduction and development of the animal is emphasised in view of the possibility of its application for artificial breeding.

After enumerating the secondary sexual characters by which the sexes may be recognised easily, the author gives a detailed description of the female and male reproductive organs. The period of maturity is estimated at 2½ years after birth in the case of females and 5 years in males. The frequency of spawning has not been established definitely, but it appears that females after the first sexual cycle lay their eggs at definite seasons, possibly biennially. Two formulæ for estimating the number of eggs produced are given and the number is computed between 3,000 and 20,000 according to size. The process of mating in crawfish is described for the first time and the preparations that the female makes for egg-laying and the actual process of laying the eggs are dealt with. No very accurate observations on fertilisation have been possible, but it is believed to be undoubtedly internal. The eggs are laid singly and are more or less like bunches of grapes. It takes the female about three to four hours to lay all her eggs.

The second part of the report deals with embryology. The maturation of the ovum is briefly referred to, and segmentation is said to start about 10 hours after the eggs are laid. Segmentation is described in great detail and the time taken for each of the different stages is mentioned. The gastrula stage takes about 10 days to appear and the stage corresponding to the nauplius develops inside the egg in about 35 days after fertilisation. The appearance of a median eye about 50 days after fertilization and its persistence till after hatching is of special interest. About 95 days after fertilization the larva hatches out.

The third part deals with metamorphosis and subsequent growth. The first free swimming stage, the "prenaupliosoma," was observed about 8 hours before the "naupliosoma", which had so far been considered as the first free swimming stage. Both these stages are described in detail. The naupliosoma by a direct metamorphosis and ecdysis gives rise to "phyllosoma", about 8 days after hatching. This passes through different stages till it is about 35 mm. long. By a striking metamorphosis this now changes into a "puerulus" of 22 mm., which in all essentials is like a small adult. This grows in size and after passing through some more stages assumes the characters of a fully grown crawfish. The latter part of the life-history has still to be worked out in detail. The rate of growth is slow and a very young specimen kept under observation grew only 0·25 inch in nearly two years, but possibly the rate is somewhat accelerated as the age advances.

The last chapter briefly gives the technique employed in studying the eggs and in preparing photomicrographs. The information contained in this section is very useful.

The report concludes with a short bibliography, which includes practically all the important references on the subject.

The paper is illustrated with 12 plates, a large number of which are direct photomicrographs. The different parts of the animal and the life-history, including the various developmental stages, are all very clearly illustrated.

The report under review is based on a thorough and painstaking piece of research carried out both in the laboratory and under natural conditions. It should prove of great use to the people interested in the crawfish and allied industries as also to scientific workers in general.

B. N. C.

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* "The Reproduction, Embryology and Metamorphosis of the Cape Crawfish, *Jasus lalandii* (Milne-Edwards) Ortmann." *Investigational Report No. 6 of the Department of Commerce and Industries*, Fisheries and Marine Biological Survey Division of the Union of South Africa.

CENTENARIES

S. R. Ranganathan, M.A., L.T., F.L.A.
(*University Librarian, Madras*)

Hoff, Karl Earnst Adolph Von (1771–1837)

K. E. A. VON HOFF, German diplomat and amateur geologist, was born at Gotha on November 1, 1771. In his seventeenth year he entered the University of Jena and proceeded after two years to Gottingen. In 1791, he became Secretary of Legation under his own Government of Gotha. He was in active diplomatic service right through the Napoleanic period and the years that immediately followed Napolean's fall.

Urge for Scientific Work

Yet amid all the excitement of the times, Von Hoff was pursuing his study of geology under the urge he received for scientific pursuit from the inspiring personality and scientific career of Dr. Johann Friedrich Blumenbach, justly known as the founder of Anthropology. He explored the forests of his native district of Thuringia in a number of geological excursions. He was thoroughly familiar with the extant geological literature. He popularised Hutton's geological theory in the Continent and took a leading part in freeing geologists from their then popular catastrophic school.

His Writings

His urge for dessiminating geological knowledge was so intense that he founded in 1801 his own periodical for the purpose, under the title *Magazin fur die gesammte Mineralogie, Geognosie, etc.* His first three contributions appeared as the first three articles in that *Magazin.* As many as 46 papers of his were published during the next 35 years, the last paper being the one entitled *Weben des barometrische Nivellement Von Thuringen*, which appeared in 1835 in volume 12 of *Berghens annalen.*

His Famous Work

His most famous work is the *Geschichte der durch Uberlieferung nachgewiesenen naturlichen Veranderungen der Erdoberflache* 3V. 1822–34. This is said to be a work of immense originality and free from the prejudices of his day. Two more supplemental volumes came out posthumously in 1840–41, with the special title *Chronik der Erdbeben und Vulhanansbruche.* These two volumes constitute a valuable and praiseworthy piece of work on earthquakes. It begins with the year 1606 B.C. and colses with the year 1805. For the next fifteen years there are no entries. Then follow the annual lists till 1832. Von Hoff was the first to issue annual lists of earthquakes and the first also to compile a general catalogue of earthquakes for the whole world. His first ten annual lists were published in the *Annalen der physik und chemie.* They relate to the years 1821–1830. Those for the years 1831 and 1832 were published only in his *Chronik.* Taking all the twelve years together, the number of earthquakes per annum ranges from 17 to 95. The total number of earthquakes chronicled by Von Hoff is 2,225.

Von Hoff died at his native place, Gotha, on May 24, 1837.

Hicks, Henry (1837–1899)

HENRY HICKS, Doctor by profession and Stratigraphist by fame, was born on 26 May 1837, at St. David's, Pembrokeshire. His father was a surgeon. His early education was at the local Cathedral Chapter School. He studied medicine at Guy's Hospital and became a member of the Royal College of Surgeons in 1862. He then returned to practice at his native town. In 1871, he went to practice at Hendon in Middlesex. In 1878 he specialised in mental diseases and got the M.D. degree of St. Andrews. This helped him to become the head of a lunatic asylum for ladies located at Hendon Grove. This new appointment, which he kept till his death, freed him from the interruptions of ordinary practice.

Diversion to Stratigraphy

The diversion to stratigraphy, to which he owes his prominent position in the world of science, was due to the influence and help of his friend, John William Salter, Palæontologist to the Geological Survey. In 1863, the first year of his practice at St. David's, Hicks' attention was attracted to geology by Salter's discovery, for the first time in Great

Britain, of the remains of the large Trilobite Paradoxides in the "Lower Lingula Flags" of St. David's. Dr. Hicks' curiosity was roused. He commenced to search for fossils among the old rocks around him. As he himself has said, the enthusiasm with which every new find was welcomed by Salter, "to whom they were first sent, was in itself a sufficient stimulus for any exertions required." Salter secured for him a grant-in-aid from the British Association. In the 1864 meeting at Berth, Salter reported that the energetic work of Hicks "has already brought to light more than thirty species of fossils". These discoveries "made a large addition to the Primordial fauna".

HIS CONTRIBUTIONS

Hicks pursued his work with unflagging devotion. He pushed his enquiries into the very oldest pre-cambrian rocks, both in Wales and Scotland. He also gave attention to the strata immediately preceding the present order of things and pursued with equal ardour, the evidences of glaciation in South Wales and Middlesex, the records of old bone-caves and the remains of mammoth in the Thames Valley. No man had a keener eye for fossils. To his eyes, rocks which had for long beeen deemed unfossiliferous disclosed evidences of past life. In 1890, Hicks turned his attention to North Devon and he was the first to discover a rich fauna in the Morte slates of that region, which were considered to be entirely unfossiliferous.

HIS WRITINGS

He published 82 papers in his life-time. The first paper entitled *On the lower lingula flags of St. Davids* appeared in V. 5 of the *Proceedings* of the Geological Society in 1864. The last formal paper was on *The age of the Morte Slate fossils.* It appeared in V. 4 of the *Geological magazine* in 1897.

HIS HONOURS

Hicks was greatly respected for his enthusiasm for his hobby. He himself used to say that in his busy professional life, he found geology a "means of recreation and of much intellectual enjoyment". He took a prominent part in scientific organisations. He was President of the Geologists' Association from 1883 to 1885 and of the Geological Society from 1896 to 1898. The Geological Society awarded him the Bigsby Medal in 1883. The Royal Society of London elected him one of its Fellows in 1885. He was a Honorary Member of several foreign learned bodies. He was often involved in controversy, but he enjoyed an intellectual battle, the stress of which never ruffled the course of friendship for more than a moment.

An attack of rheumatic gout affected his heart and proved fatal on November 18, 1899.

ASTRONOMICAL NOTES.

1. **Total Solar Eclipse.**—There will be a total eclipse of the sun on June 8th, 1937, but the phenomenon will be completely invisible in India. The path of totality commences about 1,500 miles to the north-east of Australia and crossing the Pacific Ocean, ends at sunset in Peru on the west coast of South America. The duration of totality will be $7^m. 4^s$. in the middle of the path. It is announced that an American expedition is proceeding to one of the islands in the South Pacific for observing the eclipse.

2. **Planets during June 1937.**—Venus will be a morning star throughout the month and will attain greatest elongation from the Sun (46° W.) on June 27. Mars is favourably situated for observation during the greater part of the night; its angular diameter will be 18″ and the stellar magnitude −1·5 nearly equalling Sirius in brightness. The planet will be stationary on June 28. Jupiter and Saturn will also be interesting objects and can be well observed late in the night; the former rises at about 9 p.m. in the middle of the month and the latter about midnight reaching the meridian early in the morning.

3. **The Milky Way.**—Many of the rich fields of the galaxy will be in a favourable position for observation, about midnight in the month of June. The star clouds in

Sagittarius and the dark patches and lanes in the region of Ophiuchus form interesting objects for study. The globular cluster Messier 13 in the constellation Hercules is just visible to naked eye and can be observed with advantage even with instruments of moderate power.

4. **Comet Notes.**—Information has been received of the discovery on February 27 of a comet by A. Wilk at Cracow (Poland) and independently on the same day by L. C. Peltier in America. The comet was at the time near maximum brightness and has since been fading rapidly. Comet 1937 *b* (Whipple) has been well observed and its brightness is slowly increasing; it should be visible by instruments of small aperture. On the 9th May, it was a fairly easy object of magnitude between 8 and 9 in the constellation Ursa Major.

5. **A White Dwarf Star.**—In Pulkowa Observatory *Circular* No. 19 A. N. Deutsch draws attention to the peculiarities of the Star B.D. + 59°·2723. Its position is given by R.A. 23^h 22.0^m, Declination 60° 50′ N. and its spectral type is F2. It has a proper motion of about half a second of arc annually, and a parallax of 0·019 is given in Schlesinger's new *Catalogue*. The absolute magnitude computed from these values is + 7, the luminosity thus being about 1/7 that of the sun.

T. P. B.

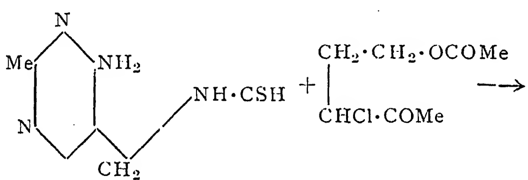
Indian Science Abstracts.

THE National Institute of Sciences of India, Calcutta, resolved to issue a publication under the title "INDIAN SCIENCE ABSTRACTS" with the sub-title "*being an annotated bibliography of Science in India*". The first part of the publication appeared in July 1936, and the general editor realising the impossibility of making such a publication complete without the active co-operation of all scientific workers in the country, requested them to look through it and see whether all their scientific publications issued during the year 1935 had been included in it (see *Curr. Sci.*, 1936, **5**, 16). The second part which has just been issued is complimentary to the earlier part, and the two together constitute a complete record of all the publications issued during 1935 in India, as also of papers published abroad on work done in India or based on Indian material.

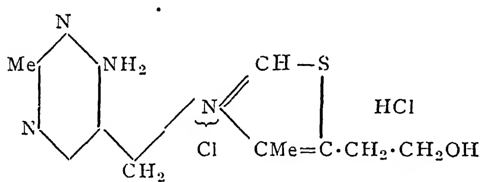
The matter is arranged under nine sections:—I. General, II. Mathematics (including Mathematics, Astronomy and Geodesy), III. Physics (including Physics and Meteorology), IV. Chemistry (including Pure and Applied Chemistry), VI. Geology (including Geology, Palæontology, Mineralogy and Geography), VII. Botany (including Pure and Applied Botany, Forestry and Agronomy), VIII. Zoology (including Pure and Applied Zoology, Veterinary Zoology and Anthropology including Technology), IX. Physiology (including Animal Physiology, Veterinary Pathology and Bacteriology and Medical subjects). The publication represents an ably edited document of nearly 200 pages. All those interested in the scientific progress of the country will be greatly indebted to the general editor for his painstaking efforts in bringing out a volume which will portray to the world of international science the contributions made by the scientific workers in India.

RESEARCH ITEMS.

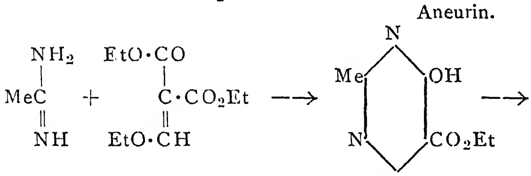
Synthesis of Aneurin (Vitamin B_1).—Todd and Bergel have recently described (*J. C. S.*, 1937, 364) a synthesis of aneurin; details of previous reported syntheses (*cf.* Williams and Cline, *J. Amer. Chem. Soc.*, 1936, **58**, 1504; Grewe, *Z. physiol. Chem.*, 1936, **242**, 89) have not yet been published. The new synthesis depends on the condensation of 4-amino-5-thioformamidomethyl-2-methylpyrimidine (I) with methyl α-chloro-λ-acetoxypropyl ketone (II). Various alternative routes to (I) are described of which the most reliable is the following. Ethyl ethoxymethylene-malonate (III) condensed readily with acetamidine in presence of sodium ethoxide to give ethyl 4-hydroxy-2-methylpyrimidine-5-carboxylate (IV) which after successive chlorination with phosphoryl chloride and heating with alcoholic ammonia under pressure yielded ethyl 4-amino-2-methylpyrimidine-5-carboxylate (V). After conversion of (V) into the corresponding amide with concentrated aqueous ammonia, the product was dehydrated to give the nitrile 4-amino-5-cyano-2-methylpyrimidine (VI) which on catalytic hydrogenation yielded 4-amino-5-aminomethyl-2-methylpyrimidine (VII) isolated as the hydrochloride. From (VII), (I) was readily obtained on treatment with aqueous potassium dithioformate. (I) and (II) gave aneurin on heating together at 115–120° for a few minutes.



(I) (II)



Aneurin.



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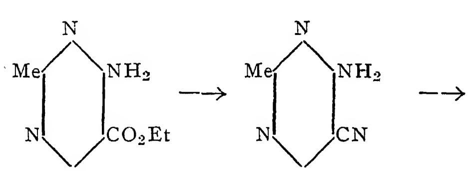

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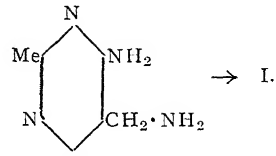

(VIII)

S. W.

The Search for Element 87.—The first search for element 87 was made by K. T. Bainbridge in 1929. Studying the likely sources by the positive ray method, he failed to detect in them the presence of the element. F. Allison and E. J. Murphy (1930) applying their magneto-optic method reported the discovery of the element in lepidolite and pollucite. Their method however is open to question. In 1931, J. Papish and E. Wainer announced their finding of several of the X-ray lines of element 87, using a concentrate derived from samarskite. Hulubei (1936) examined a pollucite extract by means of the X-ray spectrograph and obtained two lines which he considered as the $L\alpha_{1,2}$ doublet of element 87.

F. R. Hirsh Jr. (*Phys. Rev.*, 1937, **51**, 584) has repeated the experiments of Papish and Wainer and has been able to reproduce the lines. He has shown, however, that the lines are not due to element 87 but are caused by the photographic registration of the surface defects of the calcite crystal employed. (It is of interest to note that the calcite crystal used by Hirsh is the same as was used by Papish and Wainer). On oscillating the crystal to eliminate the defect, the lines disappear completely. Hirsh has further examined the results of Hulubei and has shown that it is more plausible to interpret the lines obtained by the latter as the $L\beta_3$ and $L\beta_1$ lines of mercury (with which his X-ray tube target was contaminated). In view of these considerations Hirsh concludes that the search for element 87 is still open.

K. S. G. D.

Atomic Weight of Oxygen.—Smith and Matheson have reported (*J. Res. National Bureau of Standards*, 1936, **17**, 625–628) the results of their work on the difference in atomic weights of oxygen from air and from water. Accurate determinations of the density of water were made by using the twin quartz pycnometer, employing specimens of water prepared by the union of atmospheric oxygen and of oxygen derived from water respectively, with specimens of hydrogen which had been brought to uniform isotopic composition by the usual process employing ammonia. Samples of water so prepared differed only in respect of the isotopic composition of the oxygen present in them. The observed mean difference in density was 8·6 p.p.m., the water derived from atmospheric oxygen being the heavier. This difference in density corresponds to a

difference in atomic weight of 0·00014 between atmospheric oxygen and oxygen present in water.

K. R. K.

Silica in Portland Cement.—A rapid method for the determination of silica in Portland Cement has been described (Edwin E. Maczkowske, *J. Res. National Bureau of Standards*, 1936, **16**, 549–553). The method consists in mixing the sample of cemert with roughly an equal quantity of ammonium chloride, digesting the mixture with hydrochloric acid for about half an hour and filtering off the silica as usual. This shortened procedure avoids the tedious double evaporation customary in silica determinations. The results obtained by this procedure have been compared with those obtained by the standard method and have been found to be reliable.

K. R. K.

The French Sugar Scale.—The French Sacharimeter Scale yields values for sucrose content which differ by about 0·1 per cent. from the values obtained with the International Scale (Frederick Bates and Francis P. Phelps, *J. Res. National Bureau of Standards*, 1936, **17**, 347–353). This is due to the incorrectness of the normal weight of sugar prescribed by the French Technologists. This paper points out that correct calculation of the data obtained by French investigators leads to a figure for normal weight which is identical with the International Standard, namely, 16·269 g. It is, therefore, recommended that the French Sugar Scale should be rectified by discarding the present normal weight of 16·29 g. and employing instead the International value, *viz.*, 16·269 g.

K. R. K.

Biological Digestion of Garbage with Sewage Sludge.—The underground sewerage system of removal of household wastes developed so far and the methods of purification adopted thereto have concerned themselves mainly with fluid wastes. Quite recently, however, attempts have been made, principally in America, to grind up the solid wastes, *e.g.*, waste-food (garbage) by electric motors and to convey them through the sink and plumbing into the sewers. This improvement, if adopted on the large scale, would ensure a more complete removal of waste material and at the same time serve to enrich the sewage with substances of high manurial value. The slow progress, however, which such an extension of the sewage method to the disposal of garbage has made so far, would draw attention to certain difficulties that lie in the way of its adoption, from the engineering as well as chemical points of view, *e.g.*, questions involving the capacity and ability of plumbing systems and sewers to convey ground garbage suspended in water, the nature of the increased load placed upon sewage treatment plants, the factors controlling the digestion of garbage with sewage, the optimum dosage of garbage which could be successfully manipulated, etc.

In an interesting pamphlet issued by the University of Illinois (*Bulletin* No. 24, Nov. 20, 1936), Dr. Babbitt and co-workers have subjected the chemical factors underlying the biological digestion of garbage with sewage, to a critical examination, conducting their experiments on a semi large scale. They find that garbage could be satisfactorily digested with sewage sludge, provided that it is finely ground and intimately mixed with the sludge and the percentage of sewage solids is kept above 20% (preferably about 40%) of the total volatile solids. The digestion could be carried out in Imhoff tanks, provided the rate of feeding did not exceed 1½ tons of wet garbage per million gallons of sewage. Temperature controlled digestors could be operated successfully at a loading equipment of about 3 c.ft. of digester capacity *per capita*, based on a retention period of 30 days. The rate of gas production was markedly increased by the addition of lime (but not of caustic soda or soda ash), the peak being reached at 3 c.ft. of gas per day per c.ft. of tank capacity.

C. N. A.

Disperse Systems in Gases : Dust, Smoke and Fog.

THE study of disperse systems in gases is of great interest from the theoretical and technical standpoints and has received considerable attention from chemists and physicists. The discussion organised by the Faraday Society in April 1936 has considerably helped workers in this field by placing before them the present position of the several aspects of the subject.

General Properties of Aerosols.

In the introductory paper Whytlaw-Gray (p. 1042)* has briefly dealt with the general properties of disperse systems in gases, pointing out the scope of the subject under discussion.

The Formation of Aerosols.

The work of Stumpf and Jander (p. 1048) dealing with several methods of preparing finely divided and approximately unidisperse smokes in reproducible ways is of special importance for the systematic investigation of the dispersoids. Cawood and Whytlaw-Gray (p. 1059) have studied the effect of pressure on the photochemical production of ferric oxide aerosols. Their experimental results lead to the conclusion that the condensation nuclei are larger at lower pressures than when pressures are high, though as

* References are to the pages in the Monograph (*Trans. Faraday Soc.*, 1936, 1042–1297).

Goodeve (p. 1066) has pointed out from theoretical considerations that at all pressures, the primary particle should be the ferric oxide molecule itself. Regarding the formation of mineral dusts met with in industry, the work of Green (p. 1091) is of interest; he has examined such dusts with regard to their size distribution. It is shown that most of the particles are $0 \cdot 2\,\mu$ to $2\,\mu$ in diameter. He has suggested that dusts are formed by the release of fine particles from the freshly formed surface and is closely connected with secondary structure in crystals. Philip (p. 1182) has considered the mechanism of formation of the aerosol that obtains when air charged with hydrochloric acid gas is passed through a solution of sodium hydroxide containing traces of ammonium hydroxide.

Stability and Coagulation of Aerosols.

Whytlaw-Gray has pointed out in the introductory paper that there is no evidence to show that stabilisation of aerosols can be brought about by protective colloids; R. S. Bradley's (p. 1088) theoretical considerations support this view. Any influence of the foreign substance on the formation of a fog should be interpreted on the basis of the effect that may be produced by the added substance on the size and form of the primary crystals (Fuchs, p. 1055). Fuchs has pointed out that stabilisation of a unipolarly charged cloud cannot be obtained by charging the walls of the containing vessel. If all the walls are charged to the same potential there will be no field inside. If however the potential varies along the walls of the vessel, the cloud moves across and settles at some portions of the walls. Smoluchowski's theory for rapid coagulation should therefore be applicable for aerosols. Harper's paper (p. 1139) on the theory of coagulation and the discussion thereon have definitely shown that there is no doubt regarding the correctness of the coagulation coefficient as calculated on the basis of Smoluchowski's theory. The disagreement with experiment observed by Cawood and Whytlaw-Gray (p. 1059) at lower pressures is ascribed to the heterogeneity of smoke and the departure of the shape of the particles from sphericity. The unusual stability of sulphuric acid mist obtained when sulphur trioxide reacts with water is shown by Dooli and Goodeve to be due to the formation of sulphuric acid droplets and not S_2O_6 as assumed by Sackur. Sulphur trioxide readily combines with water vapour and the droplets thus formed are big and exhibit but feeble Brownian movement. Collision with the liquid is therefore inappreciable and the droplets are quite stable. Remi shows that the absorption of sulphuric acid mist is mainly due to the turbulence of the air carrying the mist.

The course of coagulation under the action of sonic and ultrasonic waves has been followed up by photo-micrographic and kinematographic methods by Brandt and Hiedemann (p. 1101). There are two principal phases of the process as revealed by photo-micrographs taken at short intervals after the sonic waves are set up. In the first, the particles oscillate under the influence of the waves, take part in general circulation between node and antinode, and increase in size in the sound field by collision. In the second phase, the particles are so much enlarged that they no longer oscillate, but describe irregular tracks. The rate of growth of particles is studied by sedimentation velocity and nephelometric methods and is found to increase with sound intensity and time. Flowing aerosols of ammonium chloride and tobacco smoke were found to be effectively coagulated and precipitated by an air-jet generator of sound waves. Experiments with ultrasonic waves, however, are found to give different results. All particles do not oscillate and under certain conditions the particles rotate round one another without colliding and thus there is no coagulation. The theoretical aspect of coagulation under the influence of supersonic waves has been studied by Andrade (p. 1111) with certain simplifying assumptions. Andrade's theoretical considerations have been experimentally supported by Parker (p. 1115), who has worked with magnesium oxide smoke at a frequency of 220 k.c. a second. Grant has pointed out (p. 1120) the possibility of large-scale application of supersonics as a preliminary to electrical precipitation for removing smoke and dust particles from gases.

Particulate Volume in Aerosols.

Whytlaw-Gray, Cawood and Patterson (p. 1055) have described a sedimentation method for counting the number of particles present per unit volume in a smoke. Hill (p. 1125) has investigated the use of a photoelectric density meter to measure the optical density of smoke stains obtained by drawing a known volume of aerosols through a restricted area of filter paper. The concentration of smoke has been estimated to an accuracy of five per cent. The method has been employed in the measurement of atmospheric pollution.

Mass and Size of Particles in Aerosols.

Patterson and Cawood (p. 1084) have described the photometric and the graticule methods for determining the size distribution in smokes. These methods are applicable to a smoke having particles larger than $0 \cdot 1\,\mu$ in diameter. The mass and size of atmosphere nuclei have been determined by Nolan and Guerrini (p. 1175) by measuring the sedimentation velocity and the diffusion coefficient.

Rate of Charging of Particles by Ionic Current.

Fuchs, Petrjanoff and Rotzeig (p. 1131) have described a method for the determination of the rate of charging of floating particles by an ionic current. It consists in passing a narrow cloud-jet parallel to the axis of a cylindrical electric precipitator and measuring the charges acquired by the particles. The flowing particles are sucked into an ultramicroscopic cell for the measurement of the mass and the charge of the particles by the photographic oscillation method which has been developed on the basis of an ingenious idea of Wells and Gerke.* The particles

* *J. Am. Chem. Soc.*, 1919, **41**, 312,

are allowed to fall under the force of gravity and at the same time are compelled by an alternating electric field to oscillate in a horizontal direction. Photographing the zig-zag paths of the particles, the size is determined from the rate of fall and the charge from the horizontal velocity. Experiments were made with oil droplets of $0 \cdot 5\,\mu$ to $3\,\mu$ in radius. There was good agreement with theory when the effects due to mirror forces and diffusion of ions were neglected.

Electrostatic and Thermal Precipitation of Aerosols.

Mierdel and Seeliger (p. 1284) have discussed the general principles involved in electric precipitation. Meek and Lunt (p. 1273) have examined the conditions observed in electrostatic precipitation in view of Prinz's theory. Cawood (p. 1068) as well as H. W. Watson (p. 1073) have discussed the factors contributing towards formation of dust-free space around hot bodies. The latter has discussed the theory of his dust sampling apparatus (which is based on the principle of thermal precipitation).

Dispersoids in Country and Town Air.

Dobson (p. 1149) has dealt with the nature and the formation of fogs. Fogs are caused in a humid atmosphere by the condensation of water vapour on hygroscopic nuclei. Near industrial towns, the nuclei consists mainly of sulphuric acid droplets. In the country air (particularly near the sea-coast) sea salt particles function as nuclei. The size of the fog droplets depends upon the humidity of the atmosphere and the surface tension and osmotic pressure of the liquid constituting the droplet. The size of the droplets—rather than their number—determines the haziness of a fog. The red appearance of the sun through a town fog is due to the presence of a large number of minute dust particles in the atmosphere and not to the droplets which are much larger in size (being a few microns in radius). Kohler (p. 1152) finds the chlorine content of fog droplets to be of the same order as that of rain drops. Arguing on the assumption that the chlorine salts are the nuclei, he concludes that rain drops are not formed by the direct condensation of water vapour on the fog droplets. The nature of the dispersoids usually present in country and town air has been discussed by Coste (p. 1162). Town air mainly contains tar, coke, sulphur dioxide, ammonia, nitrous fumes, etc., all obtained from flue gases. Pollution depends upon the locality as well; thus iron oxide is generally found near railway stations. The organic suspensions consist of hairs, moulds and bacteria. Coste and Courtier (p. 1198) have investigated the sulphuric acid content of London air. The cause of several deaths and respiratory troubles brought about by the persistence of a fog for five days in the Meuse valley (Belgium) in December 1930, has been traced by Firket (p. 1192) to the sulphur dioxide present in the fog. Whipple (p. 1203) has shown by the examination of the data obtained at the Kew Observatory, that the electrical resistance of the atmosphere increases throughout the hours when pollution is occurring. This is ascribed to the capture of the positive ions by dust particles. Owens (p. 1234) in his paper on "Twenty-five years' progress in smoke abatement" has discussed the work carried out by the "Advisory Committee on Atmospheric Pollution" and has briefly indicated the broad conclusions obtained from statistics gathered at different stations.

Natural Dissipation of Aerosols and Their Practical Removal.

Bosanquet and Pearson (p. 1249) have carried further their mathematical analysis of phenomena involved in eddy diffusion in the spread of smoke and gas from chimneys. Meldau (p. 1270) has shown how fog and dust may first concentrate at unexpected places, sometimes quite remote from their place of origin and how it cannot be explained merely on the basis of wind direction. Goodeve (p. 1218) has described a centrifugal type of mist remover. Lessing (p. 1223) has dealt with the various factors that cause dust in atmosphere and has discussed the relative merits of the several methods of purification. Nonhebel (p. 1291) has described a commercial plant for the removal of smoke and oxides of sulphur from flue gases. The dissipation of fog by electrical, mechanical, thermal and chemical methods has been studied by Brunt (p. 1264). The thermal method seems to have many limitations. The chemical method, however, is more promising. It consists in destroying the equilibrium between the fog particles and the medium by the introduction of a hygroscopic substance like calcium chloride and the consequent evaporation of the fog particles.

The above review of the subject matter contained in the monograph—brief as it is—is sufficient to show the diversity of the points of view from which the study of dispersoids in gases has been approached. The monograph would no doubt be read with great advantage by all those who are interested in the subject.

B. Sanjiva Rao.

A Currency for India.

By Maurice Frydman.

(*Engineer Superintendent, Government Electric Factory, Bangalore.*)

IN the beginning, articles of human need were simply bartered and the rate of exchange depended on the relation between demand and supply. With development of the agricultural life and trade the necessity of standards of value arose, and it is remarkable, that the first standards were based on articles of immediate necessity: grain, cattle, cloth. Further development of trade created a need for an easily portable standard and first metal in general and finally gold was adopted. Adoption of a gold standard used at that time for jewellery and vessels only, coincides with a very high degree of general prosperity, when the demand for articles of first need was satisfied to a great extent, and when trade was catering to big towns and courts. Political development introduced State treasuries and a problem of replenishing them—large payments had to be made and this led to standardised metal pieces, called coins. Kings, usually badly in need of means of payment, manipulated with the coins, and their value decreased steadily, or in other words, prices were going up. Development of banking introduced paper values, which later developed into paper money by the same process of State manipulations. Ultimately paper money has replaced gold coins everywhere and gold has become now an article of trade, like any other, while currency and prices are ruled mainly by legislation.

The tradition of basing the value of paper money on the amount of gold the State will pay on demand is becoming more and more obsolete. There are very few States that will freely give gold to their citizens in exchange of paper notes. In international relations payment in gold is still current, but the general tendency towards balancing the imports and exports whenever possible by means of commercial treaties or currency depreciation has for its main purpose the elimination of gold from international relations.

The fallacy of gold as standard of value can be well shown if we take an extreme example.

A country called *Eldorado* is lined with gold bricks, but is, apart from this, completely barren. Its inhabitants will pay with gold for war material to protect themselves and other goods to maintain themselves. The gold received in payment by the countries producing goods will be stored up in bank vaults and paper money issued to finance industry and agriculture to produce more goods demanded by our *Eldorado*. Provided the supply of gold bricks is big enough, the *Eldorado* State will flourish without producing anything, while other States will slave for it. The accumulation of war material may even lead to a political supremacy of *Eldorado* and all because other States have a fancy for hoarding up gold in their treasuries.

This may be an indirect test, but direct tests also show the unsuitability of gold as standard of value. The history of the last few hundred years of the West is a history of mankind suffering from gold poisoning. The production of gold does not go parallel to the development of the means of production and this leads to deep anomalies in the world trade and to periodical depressions. To consider them as natural would be to consider periodical attacks of malarial fever natural. They are signs of disease, of lack of balance between production and consumption, in short, of an unsound currency system.

The gold standard is also not moral in the sense of interfering with the self-evident right of every individual to self-expression". The shifting of the centre of gravity on a substance which is not an article of immediate and universal need has dislocated the attitude to life of the average man. Possession, and not service has become the goal. Everybody wants to have something, and not to be something and to do something. The harm, such mental distortion of outlook is doing to the individual and society cannot be over-estimated. Imagine the cells of your body obsessed with the idea of getting fat; some tissues, capable of collecting fat will become monstrously obese, while others, the brain and the nervous system first amongst them, will suffer acute emaciation. The bankers of the system, the heart and the liver will accumulate fat and will work lazily, which will lead to still bigger deposits of fat in some of the tissues.

To say that the same happens in our present-day society will not be an exaggeration.

To improve matters a change of attitude towards money is necessary. Gold is a static standard, it encourages possession, and not production and consumption.

Enormous amounts of human effort are spent on digging out the gold from one pit, called "mine" for putting it into another pit, called "bank". Since gold does not satisfy human needs, it stands to reason that the labour is a complete waste. As a matter of fact paper currency could be issued on the basis of the gold content of the soil of the country with the same effect.

The very chemical stability of gold, praised by its partisans is rather a drawback. A depreciating currency would be infinitely better for the general welfare. But a depreciating currency alone would not be sufficient.

We do not maintain that currency reform alone will heal all wounds. It is not possible. Currency is only a tool, a technical detail of social organisation; but the right choice of a tool may have a far-reaching influence. Give mankind a standard of value that favours accumulation—it will accumulate. Give it another standard, that will encourage production and consumption—it will produce and consume with the same enthusiasm.

In our search for the most suitable form of currency for India we shall take the country as it is, and not as we would like it to be.

The main problem of India is the problem of a most appalling poverty, probably even worse than in China. One-fifth of humanity is living on or below the mere level of subsistence. The average income of an Indian is 7ps. per day.

Poverty cannot be abolished by State or private charity, however generous and extensive.

One may be fed on doles, " Winterhilfe ", " Soupes popularies " or " National relief funds " and yet remain in the same state of wretchedness. All the unemployment schemes, etc.. are nothing but production of beggars on a mass scale. Workmen dislike intensely these schemes; unearned bread is tasteless for them. They postpone physical starvation, but mental and moral starvation remain the same. Vast millions are reduced in their human dignity and their capacity for work is wasted.

In India no unemployment or poverty-relief is yet organised. It is natural because poverty and unemployment are too general. Contrary to other countries, total employment is the privilege of a minority here. The vast majoricy of the population is partially or totally unemployed. All the resources of the employed part of the population will not be sufficient to finance even the most modest unemployment scheme.

Complete abolition of poverty involves a thorough economic reconstruction of which a currency reform is a single aspect only.

Whether it will take in India the shape of a State socialism, or of a God socialism, it is not for us to venture an opinion.

Thus, the system of currency we are in search for, should be designed so that its working automatically tends to diminish poverty, in other words: (1) It will favour production; (2) It will facilitate proper distribution; and (3) It will encourage consumption. Apart from this the proposed currency should be easily understood and accepted by the poverty-stricken man himself, *i.e.*, it cannot be an abstract currency, based on price indexes or other statistical averages.

In looking through the list of human needs we find that the first is food. Its importance is out of proportion to any other. In moments of distress the satisfaction of all other needs will be sacrificed for the sake of food and family affection only proves sometimes equally strong. Food being the first necessity it is also the biggest single item of man's production. More effort is spent on the production of food than on everything else taken together. Food is also the item in which insufficiency of production, distribution and consumption is most intolerable. It makes the availability of all other necessities of life worthless.

Let us imagine that by some magic, India is deprived of all amenities of civilisation but given an abundance of pure and healthy food. A nation of well-built nudists, walking briskly from Rameshwaram to Badrinath for a stroll, begetting sturdy little boys and girls in a happy promiscuity, worshipping, if at all, *Sri Annapurna* only and friendly to each other because there would be absolutely no reason for being otherwise, may look grotesque to our worry-eaten minds, but whoever loves man for his own sake will not deny that it would be an acceptable proposition.

Food being the first and by far the most important need of man, which, when required, will be willingly exchanged against anything else, the following idea occurs immediately.

Why should not the most common and urgent necessity be made a standard of value? Will it work better? Will it fulfil the requirements of India? Will currency based on a food standard be *the* " morally sound currency " system for India?

The first thing to note is that a food currency is not a new idea. It exists and works on a small scale in all purely agricultural communities. It still exists in the Indian village economy. It is in harmony with Indian traditions. It is in the very blood of the villager, and the villager *is* India.

In ancient times gold coins were stored by tradesmen, kings and temples; the villager knew paddy only. Till very late even taxes were paid in grain and the only contribution to be paid in gold and silver were the homages offered to the ladies of the household.

The introduction in India of a foreign economic and industrial system has destroyed the village economy and ruined the very foundation of the country's prosperity. Everything had to be paid with money, with *rupees*, *annas*, *pies* and money has become a nightmare. Its value in terms of grain was changing constantly. Significant is the fact that the villager says: " so many measures of rice for a rupee " and not " so many rupees for a measure of rice ". It is because he had to purchase rupees, and never rice. He had to purchase rupees for payment of taxes, debts, implements, cloth, etc. Yet, in his mind, grain remained the standard of value and not money, which he had to get to pay off all his harassers till the next season.

Let us now make clear, what exactly we mean by the term " food currency "; with its introduction, what would be its influence on the agricultural and industrial life of the country, in what way will it affect production, distribution and consumption and how will it influence Indian trade relations with other countries.

By " food currency " we understand a system of currency in which a staple food product of the country is taken as a standard of value. In India it will be a chosen variety of paddy and wheat. A certain quantity of paddy and an equivalent from the nutritive point of view, quantity of wheat will be chosen and called a rupee. To distinguish it from the old rupee the new rupee may be named *food-rupee*. For purposes of convenience the food-rupee standard may be so chosen, as to represent the value of a rupee in terms of grain at a rate most suitable from all points of view.

Legislation will have to be passed: (1) to convert all gold obligations; (2) to control the import and export of currency grains; (3) to open State granaries, (4) to fix once for ever, the quantity of currency grain in a *food-rupee*, (5) to fix the seigniorage levied by the State when exchanging currency grain for currency notes.

The seigniorage is necessary to avoid the Government to become a merchant in grain. It may be one to two annas in the rupee. which will allow a margin of profit to all big and small grain merchants that will continue their trade within the limits of seigniorage, similar to the gold brokers of to-day.

The State granaries do not need to be many nor very big, if free railway transport of State grain is introduced, every station master may be authorised to issue food currency notes against currency grains and send the bags of grain to the State granaries.

Private hoarding of food currency notes will be prevented by proper legislation devaluing old currency notes, unless deposited in savings banks.

An additional legislation of immense importance, although not directly connected with the currency reform would be the transfer of a part of land revenue to a Crop Insurance Fund, out of which compensations for total or partial crop failures will be paid.

Let us now visualise the change as clearly as we can. We shall assume that the reform is already about 3 years old, and the storm of protests, declarations, petitions, resolutions and interpellations has subsided and the big grain merchants have chosen another field of money-making, that the villagers have thoroughly learned the welcome news that there will be no more variation of price of crops, however abundant the crop may be and the grain consumer has also learned that he does not need to pay grain above a certain rate, printed on every currency note in his pocket. The grain ports are usually deserted. Apart from this not much more changes will be found in the towns.

The real importance of the reform will be seen in the village. Every plot of land becoming virtually a gold mine and every villager a gold digger, unusual activity is observable everywhere. Grain has verbally become money—by growing grain money is grown—and everybody knows well in advance how much money is going to be grown. Every piece of land is utilised, irrigation schemes are put to execution, the selected grain varieties are sought for, agricultural improvements quickly popularised, best implements purchased, every village humming with activity, because for the first time in history the grain grower is sure of the crop, its price, its market.

Demand and supply relations govern other agricultural products, and their culture will not be forsaken, as their price will be always controlled by the value of grain that can be grown on the same land with the same amount of labour and usually they bring some small premium to the enterprising grower.

Every villager knowing exactly how much value he is growing every year, is enabled to lay out a budget and to have his own private 5-year plan. The indebtedness of the village has become possible to cope with, as the stabilised income of the villager has enabled the State to give long-term interest free loans on the security of the crops.

The industrial development of the country is tremendously accelerated. The currency notes the villager receives for his grain he has either to spend or to save. He spends on industrial products like carts, bullock shoes, lamps, hardware, paper, etc. The amounts saved are utilised by the Government for financing big irrigation and electrification schemes, reclamation of waste lands, building roads and railways. In both cases the money goes to the industries. As the industries develop and their own costs go down, prices of industrial products in terms of agricultural products go down, enabling the villager to purchase more and more. Thus the development of industries follows closely the rise of prosperity in the villages.

The State has profited in several ways. Its land revenue is stabilised and growing from year to year. The seigniorage has created a new source of income. The prosperity of the population is increasing steadily, any local famine is dealt with by the Crops Insurance Fund, and there is plenty of reserve funds for any major scheme. Food, being the currency itself, no need of curtailing its production is ever felt; when abundant quantities accumulate in the granaries, extensive sanitation, town building and road building schemes are financed, educational facilities extended and children, maternity and old-age protection schemes introduced. Heavy inheritance taxes curtail the accumulation of too big savings, money is grown intensely and spent intensely and proper balance between production and consumption maintained all the time.

Except for the severe control of currency grains imports and exports, little change can be observed in the international trade mechanism. The *Food-Rupee* being an internal currency, the international trade accounts are cleared by a special bank agency which keeps foreign money and gold stock for smoothening out the differences between exports and imports. The country's gold production, useless now for the internal economy, is more than sufficient to meet any foreign obligation, if they have to be paid in gold.

Needless to say that although the food currency will make a tremendous difference in the economy of the country and may open a new era in its development, as long as the land will be in the hands of landlords, it will make them very rich and also very dangerous. The new scheme will benefit them in the first instance. The tenants, usually left with just enough to live on till the next season, will get their benefits only indirectly, owing to increased demand for industrial and rural labour.

Yet any failure to give plenty to every individual in India will not be the fault of the currency system, but of other aspects of the present economic structure. The scheme by itself is able to foster production, facilitate distribution and increase consumption.

Can the reform be introduced immediately? Surely. It will make everybody's life easier. It requires a very simple legislation. It benefits the State and the citizen in the same measure.

Can it be introduced in a smaller area than the whole of India? Yes, provided two conditions are fulfilled:

(1) The chosen area can grow some excess of food over the needs of the population; (2) Its revenue is entirely independent and it has no outside charges; and (3) It has got freedom to regulate its imports and exports.

Some objections may arise and it will be useful to answer them in anticipation.

(1) Is it necessary to make food the currency itself? Will not a grain price policy based on State granaries do the same?

No, it will not do, as although it stabilises the prices to a certain extent, it will always be subject to the whims of the Governments and does not give the certainty, that the food currency itself can only give. Apart from this, the gold poison will not be eliminated.

(2) Will not a food currency lead to overproduction of grain? No, because human needs are various and with the increase of prosperity the population will create a demand for other agricultural products, that will become more paying to produce, than grain.

(3) The food currency will foster barter transactions in the rural areas, with the elimination of currency notes.

It would be a welcome procedure, eliminating the middleman completely and giving to those concerned the full value for their services.

(4) It will be difficult to collect taxes in grain.

Taxes will be collected as usual, in currency notes. Exchange of grain against currency notes is done separately, preferably by the station masters.

(5) The State will incur heavy losses by accidental deterioration of grain.

The modern granaries can keep grain for very long periods. If the reform is passed by the Government, we undertake to design air conditioned and ventilated granaries in which grain will keep as long as in the Egyptian Pyramids.

(6) A heavy load will be put on railways.

Not at all; State granaries will not be big at all. The majority of grain transactions will pass through private hands, who will desire to profit by the seigniorage. Apart from this the increased railway traffic, due to higher prosperity, will pay off the railways generously the necessity of sending a trainload of grain free.

(7) Excess of grain will accumulate in State granaries.

Grain is a starting point in a variety of chemical industries. It can be dumped away by the State. A large percentage of currency notes issued will never be claimed to be exchanged for grain and the excess of grain can be sold to licensed chemical industries at lower rates or exported.

It is impossible in a single article to go into all the details of the scheme and to discuss all the corollaries. However utopian it may look at the first sight, it is a simple, understandable scheme. It deserves consideration—and we are sure that a generation will come that will take it seriously and put it to practice.

Stratosphere Flight in the Balloon "Explorer II".*

IN the issue of *Current Science* for April 1936, a brief summary was presented of the balloon ("Explorer I") expedition into the stratosphere; it was organised and conducted in the U.S.A. under the joint auspices of the United States Army Air Corps and the National Geographic Society. This hydrogen filled balloon with a volume of 3,000,000 cubic feet, made and equipped with meticulous care began to give way at a height of about 61,000 feet and ended in disaster; the three heroic fliers had to jump out of the gondola hurtling down under its own weight and save themselves by parachutes.

Nothing daunted, preparations for a second balloon expedition were almost immediately organised; this second balloon—"Explorer II"—was bigger by 70,000 cubic feet and filled with helium instead of hydrogen to avoid all risk of explosion. As in the case of the previous expedition, a large number of scientists and scientific institutions, firms and government departments enthusiastically co-operated in the great adventure. The gondola was again a remarkable floating laboratory equipped to carry out an amazing variety of scientific measurements and observations, all automatically recorded; nature, intensity and directional distribution of cosmic rays; atmospheric ozone distribution; electrical conductivity; composition of air; pressure, temperature and wind velocity variations with height; micro-organisms in the stratosphere, etc.

On 11th November 1936 (Armistice Day), leaving the Stratobowl near Rapid City at 7 A.M., "Explorer II" safely returned to earth eight hours later, after a remarkably successful flight to the record height of 72,395 feet. The details of the flight and the preparations for it are very vividly, and with humour, described by Major Stevens, the Commanding Officer.

The theoretical and practical considerations underlying the design and construction of the balloon and the gondola; the radio telephone communication system by which the balloon was in touch with the earth throughout; the photographic and recording arrangements; the apparatus and operation for the large number of scientific observations and their automatic recording; all these are described in appropriate detail, supported by a large number of line diagrams and excellent photographs.

The results of the examination and analysis of the various records and specimens are reported in a series of scientific articles occupying nearly two-thirds of the volume. Each of these is written by a specialist. As in the case of "Explorer I," cosmic ray investigations occupy a prominent place.

The general reader will be interested to know that the electric potential at 72,000 feet is some 400,000 volts above earth and 100,000 volts above the value at 16,500 feet. Though the air pressure is no more than about 35 mm. of mercury, the wind velocity at 70,000 feet is so high as 40 miles an hour. No wonder that under this churning action, the composition of the air at these heights differs really little from that at sea-level. Of no small significance is the evidence from the cosmic ray records that nuclear disintegrations can take place without the capture of the incident particle.

For the specialist as for the general reader, the book will be very interesting reading.

A great adventure in every way, finely planned and carried out.

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* *The National Geographic Society—U. S. Army Air Corps Stratosphere Flight of 1935 in the Balloon "Explorer II,"* Stratosphere Series No. 2, published by the National Geographic Society, Washington, 1936; Price $ 1·50.

SCIENCE NOTES.

Coronation Honours.—The names of the following men of science are to be found in the list of the recipients of the Coronation Honours:—

C.I.E.—Lieut.-Col. C. Newcomb, Chemical Examiner to the Government of Madras; Mr. J. F. Blackiston, Director-General of Archæology in India; Mr. F. Ware, Officiating Expert Advisor in Animal Husbandry to the Imperial Council of Agricultural Research, New Delhi.

Knighthood.—Brigadier H. J. Couchman, Surveyor-General of India; Col. Arthur Alver, Expert Advisor in Animal Husbandry to the Imperial Council of Agricultural Research.

Dewan Bahadur.—Dr. B. Sundar Raj, Director of Fisheries, Madras.

Rao Bahadur.—Prof. K. Ananda Rao, Presidency College, Madras.

Rai Bahadur.—Mr. Ramalal Sethi, Economic Botanist to Government, Government Research Station, Shahjanpur, U.P.; Dr. Sundarlal Hora, Zoological Survey of India, Calcutta; Dr. Karamchand Mehta, Professor of Botany, Agra College, Agra.

Rao Saheb.—G. K. Kelkar, Deputy Director of Agriculture, Southern Circle, Nagpur.

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Spinning Tests on Mixtures of Staple Fibres and Indian Cottons.—Dr. Nazir Ahmed, Director of the Technological Laboratory, Indian Central Cotton Committee, has written an interesting report (*Technological Bulletin Series*—A, No. 36) on spinning tests carried out on mixtures of staple fibres and Indian cottons. In the Introduction it is pointed out that the past few decades have witnessed a large increase in the use of artificial fibres as a supplement to, or substitute for, natural fibres, in which rayon silk has held the first position. Rayon produced in short definite lengths, called staple fibre, went up from 8 million pounds in 1931 to 21 million pounds in 1932 and then to 156 million pounds in 1935 which represented 15 per cent. of the total rayon output. This large increase is attributed to the fact that staple fibre possesses uniform length and cross-section, it is clean and therefore there is very little waste and it does not adhere to the machine. But the more important reason is that it can be mixed and blended with cotton, wool, flex and silk and spun on the existing machines with some minor adjustments. The spinners, weavers, dyers and finishers can therefore produce a wide range of effects with it.

The Bulletin gives full details of the machinery employed in these tests and the results obtained are described and discussed in detail. It is hoped that it will be found useful by the industry. It can be had from the Secretary, Indian Central Cotton Committee, 'Vulcan House', Nicol Road, Ballard Estate, Fort, Bombay, at 8 as. per copy.

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The Sugar Committee of the Imperial Council of Agricultural Research, held a two-day session (May 3rd and 4th) to discuss the various problems affecting the sugar industry. Sir Bryce Burt presided. The Committee considered the serious situation arising from the alarming expansion of the acreage under cane, resulting in the production of cane far in excess of that for which there is effective demand. In this connection it is hardly realised that the cane crushed in factories for manufacturing white sugar is $11\frac{1}{2}$ million tons, which is only about 16 per cent. of the cane produced in the country. Some 12 million tons are consumed mostly by chewing and no less than $43\frac{3}{4}$ million tons go into the manufacture of *gur*. An enormous quantity of cane is still left over. In a contribution appearing in the '*Hindu*' (May 1) Mr. D. P. Khaitan has given some interesting details regarding the Indian Sugar Industry. The production of sugar in India in 1932, when protection was granted was 158,581 tons, and 516,200 tons valued at about 6 crores of rupees were imported from abroad. It is roughly estimated that the annual consumption at present is nearly 12 lakhs tons, and in 1935–36, no less than 1,166.000 tons of sugar were produced in the country, the production being almost equal to the annual consumption. The acreage under cane was 3,076,000 in 1931–32, and in 1936–37 the acreage rose up to 4,431,000. It is estimated that no less than 2 crores of the whole population of India is dependent on the cultivation of sugarcane and the total amount paid to the cultivation of sugarcane used in the factories during the last year, 1935–36, alone came to Rs. 8 crores.

The distribution of the area under sugarcane in India is ill-ordered. The prevailing system of land tenure and the existence of small holdings constitute a handicap. The cultivation of canesugar should be spread over specially marked zones so situated that particular factories can draw the raw material they require from those zones; in other words the factories should enjoy a situational advantage. How best this could be secured, was one of the problems which was carefully considered by the Committee.

The Sugar Committee approved of the proposals for carrying out a proper marketing survey of sugar on the same lines as those adopted for the wheat survey. The Committee also considered the research programmes and work now in progress in the various experimental stations for evolving improved varieties of cane. The subject of utilisation of molasses was also considered; further trials relating to (1) the preparation of silage by mixing molasses with fibrous fodder and (2) the utilisation of molasses as a road-surfacing material will be carried out in order to relieve the sugar industry from the dead-weight of its by-product.

It is understood that representatives of the sugar industry have urged on the Government, the need for constituting a Central Sugar Committee on the lines of the Indian Central Cotton Committee to co-ordinate and guard the interests of the industry, by research, propaganda and other methods.

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Red Palm Oil.—"The nutritive value and cost of the Red Palm Oil" is the subject of a communique recently issued by the Director of Public Information.

The oil derived from the fruit of the West African Palm, *elæis guineensis*, is very rich in

carotene, the precursor of Vitamin A. Chemical tests conducted by Lt.-Col. R. E. Wright, I.M.S., Professor of Ophthalmology, Government Ophthalmic Hospital, Madras, have shown that red palm oil is as effective as cod liver oil in the treatment of several cases of human keratomalacia. In a number of cases rapid improvement took place in cases which remained living under the identical domestic conditions in which they had developed the syndrome, the only change in their daily routine being the addition of red palm oil emulsion to their diet. In addition, the progress of cases in hospital on red palm oil and cod liver oil was carefully compared. While Colonel Wright points out that clinical investigations of this nature are necessarily less clearly defined than laboratory investigations under carefully controlled conditions, he has nevertheless fully convinced himself of the effectiveness of red palm oil. The decision of so experienced a worker can be accepted as conclusive.

If red palm oil cures keratomalacia, then its carotene must be capable of satisfying the daily Vitamin A requirements of human beings.

Considering the costs, it has been calculated that the amount of Vitamin A purchasable for a given sum in the form of red palm oil will be about 3 times greater than that purchasable in the form of cod liver oil. The fact that red palm oil contains little or no Vitamin D, unlike cod liver oil, is not necessarily a drawback to its use in countries where Vitamin D is supplied by abundant strong sunlight and rickets is rare. In India, it could be used in the South and other parts where Vitamin A deficiency is common and Vitamin D deficiency not a serious problem.

The question of introducing the palm *elœis guineensis* into South India should receive attention on the part of agricultural authorities. The climate of South India would probably be suitable for its cultivation.

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The Statistical Institute.—The Annual General Meeting was held at Calcutta on the 27th April with Mr. S. P. Mookerji in the chair. The report of the research work done during the year comprises a variety of subjects such as, Agricultural Statistics, Biometry and Anthropometry, Economic Statistics, etc. Over 100 statistical enquries from all over India were attended to during the year. An important decision was reached to start an All-India Statistical Conference to be held in January 1938, and a Working Committee was formed to work out the details. With the help of the Calcutta University, arrangements have been made to invite Prof. R. A. Fisher of London, to visit India next winter.

Sir E. C. Benthall was re-elected President and Dr. P. N. Banerji, Sir George R. Campbell, Mr. D. P. Khaitan, Dr. John Matthai, Mr. S. P. Mookerji, Dr. C. W. B. Normand, Sir. C. V. Raman, Lala Shri Ram, Prof. M. N. Saha, The Hon'ble Mr. Nalini Ranjan Sarkar, and Mr. B. M. Sen were elected Vice-Presidents. Dr. Satya Charan Law was re-elected Treasurer.

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Indian Chemical Society.—At the ordinary meetings of the Society held on 4th March and on 23rd April at the University College of Science, Calcutta, the following were admitted as Fellows:—

(1) D. G. Walwalkar, M.Sc., *Cawnpore*; (2) M. A. Saboor, M.Sc., *Calcutta*; (3) Dr. U. Basu, D.Sc., *Calcutta*; (4) Dr. P. B. Sarkar, D.Sc., *Calcutta*; (5) A. Kamal, M.Sc., *Calcutta*; (6) Sisir Kumar Guha, M.Sc., *Patna*; (7) N. N. Chopra, M.Sc., *Lahore*; (8) Aree Supol, B.Sc., *Bangkok* (Siam); (9) Dr. R. K. Dutt-Roy, Dr. Ing., *Calcutta*; (10) S. A. Qureshi, B.Sc., *Peshawar*; (11) R. G. Chatterjee, M.Sc., *Darjeeling*; (12) D. P. Chatterjee, M.Sc., *Howrah*; (13) Dr. J. C. Bardhan, D.Sc., *Calcutta*; (14) G. N. Banerjee, B.Sc., *Bombay*; (15) M. Abdul Hamid, M.Sc., *Bombay*; (16) Narendra Chandra Deb, M.Sc., *Sylhet*; (17) Dr. R. C. Hoon, M.Sc., Ph.D., *Lahore*.

Dr. S. P. Roy Chaudhuri, delivered a lecture on the 23rd April on "The Nature of laterite and lateritic soils"; Prof. J. N. Mukherjee presided.

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Hyderabad Geological Survey.—*Bulletin* No. 2 recently published by the Geological Survey, Hyderabad (Deccan), under the authorship of Mr. Khurshid Mirza, Director, gives a brief outline of the geological history of Hyderabad State, with special reference to its mineral resources. In the course of the first 30 pages, the author gives a connected account of the main geological features of the State incorporating all the information hitherto collected; and in the latter half of the *Bulletin* which covers another 30 pages, attention is drawn to the deposits of economic value, of which a large number and variety have been located. The *Bulletin* will doubtless be found very useful by those who wish to have a general idea of the geology of this State, and the geological map given at the end greatly adds to the value of the publication.

Volume III, Part I of the *Journal of the Hyderabad Geological Survey*, which has also been recently published, contains three sections of which Section A is by far the biggest and deals with the geology of the eastern portion of the Raichur Doab, with special reference to the granodioritic phases of the Dharwar series of rocks. The paper embodies the work done in this area by the several officers of the Survey and gives an elaborate account of the various rocks met with in this part of the country representing the Dharwars, the Peninsular Crystalline Complex, and the Kurnool Series of Sedimentaries. The petrology of some of the more interesting rock groups such as the granodiorites and the pseudo- and quasi-charnockites has been studied in some detail and certain interesting conclusions drawn. Section B deals with the salinity in relation to soil and geology in Raichur District, and in Section C, we have an account of the Bore Well logs in Aurangabad and Parbhani Districts, discussed in relation to the distribution of underground water in the Deccan traps.

The *Journal* is well got up, and is profusely illustrated with maps, sections and photographs.

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Asphalt Mastic for Roofing.—The modern demand for waterproof flat roofs has given prominence to a number of problems connected

with the use of asphalt mastic as a roofing material. A recent report published by H. M. Stationery Office (*Building Research Special Report* No. 25, Price 9*d*.) brings together in convenient form the available information on the properties of the material and methods of testing it. The construction of the sub-roof and the laying of the mastic are described in full and a feature of the report is a set of drawings illustrating accepted practice as regards associated details. In the absence of a standard specification for the formulation of which present-day knowledge does not suffice, recommendations are made as to the selection of materials and the precautions to be taken in their use.

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Cytological Technique for Plant Breeders.—As Sir Daniel Hall says in a brief foreword to this Bulletin, a knowledge of cytology and some acquaintance with its technique has become essential to the plant breeder. The aim of the publication is to give an account of the standard methods used in plant cytology and it is based on practical experience with these methods rather than on a survey of the literature.

After an introduction dealing with the value of cytology in plant breeding and some general remarks on technique, the Bulletin describes in turn the paraffin method, including staining with iron-alum hæmatoxylin and with gentian violet, the aceto-carmine technique (a method particularly useful for plant breeders) and smears with standard fixatives and stains. Hints are given on the use of the microscope and the Bulletin concludes with a list of fixatives with formulæ and a short bibliography.

While the Bulletin has been prepared for the benefit of plant breeders, it is of course equally suitable for anybody wishing to learn these standard methods; the modest price is worth mention in this connection.

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Tooth Decay Studied by X-Ray Absorption of Tooth Slabs.—New data with regard to normal and pathological tooth conditions have recently been obtained by Drs. H. C. Hodge, S. L. Warren, G. Van Huysen and associates, of the Dental Research Group at the University of Rochester School of Medicine and Dentistry, by the use of thin tooth slabs which are surface-ground plano-parallel by the BAUSCH & LOMB OPTICAL CO. with a variation of not more than ±0·01 mm.

Attempts by other investigators to study changes in dentine by X-ray absorption have been limited because tooth slabs were not sufficiently thin or plano-parallel, thus reducing the precision of film density measurements.

In the present method several slabs of teeth, about 1 mm. thick, are obtained by slicing a tooth longitudinally through its centre by means of two parallel, corundum-vulcanite disks on a watchmaker's lathe, after which they are ground plano-parallel.

Dr. Hodge and his associates are seeking the answer to tooth decay by a study of the physical, chemical, and structural make-up of the tooth and the effect of diet and heredity. Some of the properties measured have been hardness, X-ray absorption and diffraction, chemical composition, density, refractive index, and the sizes of the tiny calcified rods that make up tooth enamel, and the smaller tubules that run out from the tooth pulp through the dentine.

According to their report, when menaced by decay or wear the tooth protects its health by building a dike of calcified material between the danger zone and the living pulp. These changes can be measured by X-ray study of the plano-parallel tooth slabs whose thickness does not vary more than 1/2500 of an inch.

When teeth wear down, exposing the dentine, the tooth closes the inner end of the tubules affected by building a plug of dentine which is as transparent as glass. To measure the hardness of these areas the surface of the tooth is illuminated with vertical polarized light which shows the transparent area as a dark area on a white background.

These studies have disclosed, among other things, that some teeth are as hard as mild steel and that dentine is as hard as brass.

By the use of the thin tooth slab, which may be X-rayed at will, the limits of accuracy and reproducibility of the method may be measured quantitatively, an achievement which has not been possible in living material.

The substitution of monkey teeth, which are nearest the human type and which suffer the same diseases, are to be included in future studies. The question as to whether soft teeth decay more rapidly than hard ones, and why, will not be answered until some 2,000 additional teeth are studied.

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Attempt on Nanga Parbhat.—The members of the second German Expedition to conquer Mt. Nanga Parbhat consisting of Dr. K. Wein (leader) and eight others are now in India and will start the climb after reaching Gilgit, by about the end of May. It is anticipated that the climb will lost about 4 weeks.

It will be recalled that an attempt was made by a German party three years ago but the attempts were foiled by the early onset of monsoon. The expedition also lost four of its members in a snow-storm. The present party consists of Prof. C. Troll and Dr. H. Hartmann, eminent geologists, who propose to collect scientific data during the climb.

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Statistical Abstract for British India.—The Government of India have recently issued the *Statistical Abstract for British India* with statistics, where available, relating to certain Indian States for 1924–25 to 1933–34. This is the 13th issue of the *Abstract*. The statistics presented relate to a variety of subjects such as Area and Population, Police and Prisons, Registration, Finance, Coinage and Currency, Banks, Municipalities, District and Local Boards, Education, Press, Co-operative Societies, Agriculture and Law, Forests, Port Trusts, Emigration, Vital Statistics, Road, Railway and Steamer communications, Trade, Posts and Telegraphs, Meteorology, Irrigations, Industries, Patents, Mineral production, etc., etc. The statistics relating to Agriculture and Co-operative Societies generally relate to the year running from July to June. All the other tables relate either to the fiscal year ending 31st March, or to the calendar year and where the latter is the case the fact is clearly indicated in the tables.

Maynard Ganga Ram Prize.—Prof. R. S. Jai Chand Luthra, I.A.S., Professor of Botany, has been awarded the prize for 1935, in consideration of his researches on the Control of Loose Smut of Wheat. This disease is prevalent in most parts of Punjab and causes considerable loss to cultivators. The old method of control involved treatment of the wheat before sowing with hot water and unless carried out by skilled workers, it was prone to affect the germinating power of the seed. Prof. Luthra's method which is far simpler, consists in treating the seed merely in water at ordinary temperatures for four hours during the morning of a day in summer, after which the soaked seed is spread out to dry in the sun. Experience has shown that this treatment is effective in controlling the disease.

The award for 1932 has also now been announced. The recipient of the prize is Mr. T. A. Miller Brownlie, lately Agricultural Engineer to Government, of Punjab, for his invention of a slip strainer suitable for water augmentation of supplies derived from bores sunk in open wells. This strainer has the particular merit that it is not affected by alkaline sub-soil water.

The award which is of the value of Rs. 3,000 is due to the munificence of the Late Sir Ganga Ram, KT., C.I.E., M.V.O., R.B., who in 1925, handed over to the Punjab Government a sum of Rs. 25,000 for the endowment of a prize, to be awarded every 3 years for a discovery or an invention or a new practical method which will tend to increase agricultural production in the Punjab on a paying basis. The competition is open to all, throughout the world.

The first award which was due in 1929 was made in 1931, to Dr. Barber, late Imperial Sugar Expert, for his fundamental discoveries which resulted in the production of Coimbatore Sugarcane.

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Rao Bahadur M. Vaidyanathan, Statistician, Imperial Council of Agricultural Research, has been granted study leave for 8 months. He will be visiting the United Kingdom, where he will study problems connected with Agricultural Experimental technique in collaboration with the foremost Statisticians of England, Prof. Fisher, Wishart and Yates.

Rao Bahadur M. Vaidyanathan will be sailing from Bombay on the 17th June.

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Agra University.—The Executive Council of the Agra University, it is understood, have accepted the recommendations of the Committee appointed to consider the desirabiity of publishing a Journal, and have accordingly decided to issue annually a Journal, confined to the work done in the University. The Journal will comprise of two parts; Part I will comprise reports of original research work and the other part will contain summaries of extension lectures delivered under the auspices of the University.

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University of Calcutta.—The Sub-Committee appointed by the University of Calcutta to go into the question of instituting a Degree course in architecture has submitted its report recommending a 4-year course followed by a one year's training in the office of a practising architect recognised for the purpose by the University.

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University of Mysore.—The results of the Medical Examinations and the B.T. degree examination held in March 1937 were announced. They were as under:

	Examination		No. examined	No. passed
1.	First L.M.P.	..	49	36
2.	Second L.M.P.	..	52	31
3.	Third L.M.P.	..	40	25
4.	Final L.M.P.	..	58	24
5.	Final M.B.B.S. (Part I)	..	27	18
6.	Final M.B.B.S. (Part II)		25	17
7.	B.T. ..	..	60	39

* * *

New Zeiss Apparatus.—After many years of experimenting Messrs. Carl Zeiss are now putting on the market their camera-microscope *Ultraphot* an instrument which has been eagerly looked forward to by many Zeiss friends.

The Ultraphot may truly be said to fulfil the wishes entertained by the supporters of "Camera Microscopes". Every branch of microscopy and photo-micrography has been duly considered in the construction of the instrument, combining monocular and binocular observation in bright and darkfield illumination by ordinary and polarised light for transparent and opaque objects with photomicrography at lowest, medium and highest magnifications. It is possible to attach Kinematographic apparatus of both standard and sub-standard size of films, and even such a specific kind of investigation as the observation and photography in luminescent light or as the photography in the ultra-violet and infra-red regions of the spectrum have been rendered practicable. For metallography, provision is made for using the Ultraphot as an inverted microscope with camera.

Particular attention has been paid to the illuminating device so often neglected in similar instruments. Exacting requirements, for which the Ultraphot has essentially been constructed, demand the fundamental principle of illumination—*i.e.*, that the image of the source of light should be projected into the aperture of the image-forming system—which is conveniently complied with by simple manipulations for all sizes of field and apertures.

* * *

Announcements.

Indian Science Congress.—For the occasion of the Silver Jubilee session of the Indian Science Congress, to be held in Calcutta from January 3rd–9th, 1938, certain Sections have been split up, and three new Sections thereby created. The complete list of Sections with their Presidents is as follows:—

(1) *Mathematics and Physics*: Dr. C. W. B. Normand, Director-General of Observatories, Meteorological Office, Poona, 5; (2) *Chemistry*: Prof. S. S. Bhatnagar, Director, University Chemical Laboratories, Lahore; (3) *Geology*: Mr. D. N. Wadia, Offg. Supdt. Geologist, Geological Survey of India, 27, Chowringhee, Calcutta; (4) *Geography and Geodesy*: Dr. A. M. Heron,

Director, Geological Survey of India, 27, Chowringhee, Calcutta; (5) *Botany*: Prof. B. Sahni, Professor of Botany, Lucknow University, Lucknow; (6) *Zoology*: Prof. G. Matthai, Professor of Zoology, Government College, Lahore; (7) *Entomology*: Mohamad Afzal Husain, Principal, Punjab Agricultural College, Lyallpur, Punjab; (8) *Anthropology*: Dr. B. S. Guha, Zoological Survey of India, Indian Museum, Calcutta; (9) *Agriculture*: Rao Bahadur T. S. Venkatraman, Imperial Sugarcane Specialist, Lawley Road, Coimbatore; (10) *Medical Research*: Sir U. N. Brahmachari, Kt., 82/3, Cornwallis Street, Calcutta; (11) *Veterinary Research*: Col. A. Olver, Animal Husbandry Expert, Imperial Council of Agricultural Research, New Delhi; (12) *Physiology*: Brev. Col. R. N. Chopra, Director, School of Tropical Medicine, Chittaranjan Avenue, Calcutta; (13) *Psychology*: Dr. G. S. Bose, University College of Science, 92, Upper Circular Road, Calcutta.

Under the new rules of the Association, the abstracts of papers will be printed in final bound form before the meeting. *The Executive Committee have, therefore, fixed August 15th as the last date for the submission of papers and abstracts.*

Since it is desirable that a very high standard should be maintained on the occasion of this session, the Executive Committee have decided that *no abstracts will be printed unless accompanied by the full paper at the time of submission*, thereby enabling the papers to be refereed by the Sectional Committees.

Regarding the Botany Section, Prof. B. Sahni, the President, has divided his section into six Sub-sections, with separate Chairmen. He asks us to request intending contributors to send their papers direct to the Chairmen of the appropriate sub-section, who will act as referees and advise the President. The following are the six Sub-sections:—

Cryptogams: M. O. P. Iyengar, Professor of Botany and Director, University Botanical Laboratory, Madras; *Phanerogams & Taxonomy*: S. P. Agharkar, Ghose Professor of Botany and Head of the Department of Botany, University of Calcutta; *Genetics & Cytology*: Dr. (Miss) E. K. Janaki Ammal, Geneticist, Imperial Sugarcane Station, Lawley Road, Coimbatore; *Mycology & Plant Pathology*: K. C. Mehta, Professor of Botany, Agra College, Agra; *Physiology & Ecology*: P. Parija, Professor of Botany, Revenshaw College, Cuttack; *Palæobotany*: B. Sahni, Professor of Botany, University of Lucknow.

As far as possible the meetings of the subsections will be held consecutively, in a continuous programme, so as to avoid their overlapping with each other.

* * * *

The Inter-University Board.—The next annual session will be held at Allahabad in the month of November during the Golden Jubilee Celebrations of the Allahabad University.

We acknowledge with thanks the receipt of the following:—

"Agricultural Gazette of New South Wales," Vol. 48, No. 4.

"Indian Journal of Agricultural Science," Vol. 7, No. 1.

"Monthly Bulletin of Agricultural Science and Practice," No. 4, April 1937.

"Journal of Agriculture and Livestock in India," Vol. 7, No. 2.

"The Philippine Agriculturist," Vol. 25, No. 9.

"Journal of the Royal Society of Arts," Vol. 85, Nos. 4401–4404.

"Chemical Age," Vol. 36, Nos. 926–929.

"Journal of Chemical Physics," Vol. 5, No. 4.

"Journal of the Indian Chemical Society," Vol. 14, No. 2.

"Russian Journal of General Chemistry," Vol. 7, No. 2.

"Experiment Station Record," Vol. 76, No. 3.

"Transactions of the Faraday Society," Vol. 33, Part 4.

"Indian Forester," Vol. 63, Nos. 4 and 5.

"Indian Forest Records," Vol. 2, No. 12.

"Forschungen und Fortschritte," Vol. 13, Nos. 10–12.

"Transactions of the Mining and Geological Institute of India," Vol. 31, Part 3.

"The Calcutta Medical Journal," Vol. 32, Nos. 4 and 5.

"Review of Applied Mycology," Vol. 16, No. 3.

"Journal of the Bombay Natural History Society," Vol. 39, Nos. 4 and 5.

"Nature," Vol. 139, Nos. 3518–20.

"Canadian Journal of Research," Vol. 15, No. 3.

"Journal of Research, National Bureau of Standards," Vol. 17, No. 6.

"Ceylon Journal of Science," Section B, Vol. 20, Part 2 and Section D, Vol. 4, Part 3.

"Science and Culture," Vol. 2, No. 10.

"The Sky," Vol. 1, No. 6.

"Science Progress," Vol. 31, No. 124.

"Indian Journal of Venereal Diseases," Vol. 3, No. 1.

Government of India Publications:—

"Indian Trade Journal," Vol. 134, Nos. 1608–11.

"Bulletin of Industrial Research," No. 7.

CATALOGUES:

Messrs. Bausch and Lomb: "Research Microscopes and Accessories."

Messrs. Verlag von Gustov Fischer in Jena.

ACADEMIES AND SOCIETIES.

Indian Academy of Sciences :

April 1937.—SECTION A.—R. S. KRISHNAN: *Dispersion of Depolarisation of Light-Scattering in Colloids—Part II. Silver Sols.*—It is inferred that the particles of silver sols behave optically like elongated ellipsoids with the axial ratio equal to 0·75. It is suggested that the colloidal particles of silver may be in the form of minute octohedra which can be considered as optically equivalent to a prolate spheroid of the axial ratio 0·75. N. W. HIRWE AND B. V. PATIL: *Derivatives of Salicylic Acid—Part XI. Bromo-Salicylic Acids and their Methyl Ethers.*—A detailed study of these acids was undertaken as their chloralamides were required for other work. B. B. DEY AND T. K. SRINIVASAN: *The Preparation of Ortho-Phthalaldehydic Acid.* V. SEETHARAMAN: *Differential Invariants for Path Spaces of Order* 3. S. RAMACHANDRA RAO AND S. SRIRAMAN: *The Paramagnetic Susceptibility of Lithium.*—The mean value is found to be $2 \cdot 6 \times 10^{-7}$. T. R. SESHADRI AND C. VENKATA RAO: *A New Separation of the Components of* Psoralea corylifolia, *Linn.*—The components of the seeds have been isolated and examined. K. NEELAKANTAM AND T. R. SESHADRI: *Pigments of Cotton Flowers—Part IV. Constitution of Herbacitrin and Herbacetin—New Glucoside and Aglucone (Flavonol).* T. S. SUBBARAYA, B. NAGESHA RAO AND N. A. NARAYANA RAO: *On the Band Spectrum of Mercurous Iodide.*—The bands of group III have been measured under high dispersion and analysed. T. S. SUBBARAYA, N. A. NARAYANA RAO AND B. NAGESHA RAO: *On the Band Spectrum of Cadmium Iodide.*—Results obtained during an investigation of the group III bands of CdI are presented. N. W. HIRWE AND (MISS) K. D. GAVANKER: *Derivatives of Salicylic Acid.—Part XII. Nitro-Salicylic Acids and their Methyl Ethers.*—A new method for the synthesis of 3: 5-dinitro-salicylic acid by nitration of salicylic acid is described. DR. HANSRAJ GUPTA: *On a Conjecture of Chowla.*

April 1937.—SECTION B.—COL. I. FROILANO DE MELLO AND CÆTANO CORREA DE MEYRELLES: *On the Classification and Schizogonic Cycle of a Blood Parasite of the Indian Lizard* Calotes versicolor *Daud. Subspecies* Major *Blyth.*—The parasite has many interesting peculiarities which have enabled the authors to classify it as a new species. The existence of a *paranuclear body* so often figured in *K. lacertarum* and always present in the various evolutive stages of the parasite now studied, the presence of a polar capsule in gametocytes, the evident sexuality of gametocytes, the endoglobular and endothelial cycles of schizogony, the peculiar shape and structure of the micro-merozoites have not been described in any hæmogregarinid hitherto recorded. M. K. SUBRAMANIAM AND R. GOPALA AIYAR: *An Analysis of the Shape and Structure of the Golgi Bodies in the Eggs of Invertebrates with a Note on the Probable Modes of Origin of the Golgi Network.*

Indian Chemical Society:

February 1937.—TARAPADA BANERJEE: *On the Photochemical Oxidation of Organic Substances by Hydrogen Peroxide in Acid Medium with Inorganic Sols as Photosensitiser.* B. B. DEY AND (MISS) P. LAKSHMI KANTAM: *Studies in the Cotarnine Series—Part VIII. Derivatives of 1-Aminomethylhydrocotarnine.* PRATUL NATH SEN-GUPTA AND B. C. GUHA: *Estimation of Total Vitamin C in Food-stuffs.* SHRIDHAR SARVOTTAM JOSHI AND T. MADHAVA MENON: *Studies in the Coagulation of Colloids—Part XVI.*—Further Investigation of the "Zonal effect" and the anomalous variations of the viscosity transparency and Refractivity during the coagulations of colloid antimony sulphide by Aqueous Mercury Chloride. RADHA RAMAN AGARWAL AND SIKHIBHUSHAN DUTT: *On Synthetic Coumarins—Part I.—Coumarins derived from Resacetophenone.* TEJENDRA NATH GHOSH: *Quinoline Derivatives—Part I.* M. GOSWAMI AND A. SAHA: *Composition of Boiled Oil.*—A preliminary Note. SAILESH CHANDRA SEN: *A Note on the Application of Potassium Ferricyanide Method for the Estimation of Reducing Sugars in Canejuice.* SACHINDRA NATH ROY: *A Note on the Use of Adsorption Indicator in Acidimetry and Alkalimetry.*

Society of Biological Chemists (India) :

Bangalore, 1st May 1937.—K. V. GIRI: *Magnesium activation of Tissue Phosphatases.* Y. V. S. IYER: *A Note on the Standardization of Food Materials.* V. SUBRAHMANYAN: *Volatilization of Ammonia from Soils.* M. V. GOVINDASWAMY: *Some Biochemical Factors in Mental Disorder.*

Forthcoming Events.

21–24 *June* 1937, *Simla.*—7th meeting of the Research Officers of the Central Board of Irrigation.

Besides discussing the reports of the Research Officers on the work done in their provinces during the preceding year the following new subjects will be taken up for discussion:—(1) Questionnaire on "Drains", and (2) "Note on the rise of water-table in canal irrigated areas of the Punjab," by Mr. E. S. Crump.

789-37.—Printed at The Bangalore Press, Bangalore City, by G. Srinivasa Rao, Superintendent, and Published by B. N. Sastri, M.Sc., A.I.C., A.I.I.Sc., for the "Current Science" Board of Editors, Indian Institute of Science, Hebbal Post, Bangalore.

CURRENT SCIENCE

Vol. V] June 1937 [No. 12

India's Livestock.

THE Cattle Conference recently summoned by H. E. the Viceroy at which provincial ministers and official scientific experts were present, adopted a series of resolutions covering practically the entire range of subjects discussed by the delegates. The most important among these resolutions deal with the establishment in each province of a Provincial Livestock Improvement Fund, a Livestock Improvement Board and the closest co-operation between the several ministeries and sub-committees. These resolutions have an obvious reference to the administrative control of the measures to be adopted for the improvement of cattle. In evolving the means to achieve the desired improvement, another set of resolutions dealing with the provision of grazing facilities and the appointment of competent staff for the purpose of implementing the recommendations of the Conference, were enthusiastically adopted. These resolutions were preceded by two illuminating speeches made by the Viceroy and the Member in charge of Education, Health and Lands, which give a comprehensive survey of the problems underlying the programme of work recommended to the provincial governments for adoption. In elaborating the schemes necessary for the improvement of livestock, the Member in charge of Education claimed that a big forward step has already been taken by the Central Government in the appointment of the Animal Husbandry Experts and the establishment of various research stations where higher courses in veterinary science are to be organised. On the subject of financing the various schemes contemplated by the resolutions of the Conference, the provincial ministers did not, however, receive any assurance from the Central Government of subsidies.

It seems to us that the problem of the improvement of Indian livestock is as great and complex as that of the improvement of the population of the Indian Empire. In a recent broadcast speech Mr. E. R. Smythies, Conservator of Forests, United Provinces, pointed out that India has not merely the largest cattle population of any country

in the world, but it has so much the largest that no other country can hope to compare with it. In fact to approach the Indian stock of bovine cattle, we have to group continents together, for even excluding Burma, the rest of the Indian Empire has an inconceivable number of 200 million head of cattle,—a total that exceeds the combined bovine population of North-West Europe, North America, South Africa and Australia. The density of this population in India is heaviest in the United Provinces which exceeds that of any other province by 20 per cent. For that matter the cattle population of the United Provinces alone, about 32 millions, is far in excess of the combined total of three Dominions of the Empire, *viz.*, Canada, Australia and New Zealand. This stupendous magnitude of the herd must be too baffling for any enterprising statesman or a syndicate of ministers to embark upon the colossal task of its improvement even in any single direction.

Domesticated cattle have had a direct and vital bearing upon the welfare, activities and destinies of the human society. Indeed the biologist finds it difficult to believe that there would ever have been a human race had there been no other mammals, and even if man had come into existence independently in the absence of other mammals, we might well imagine that the historical development of his civilisation would have proceeded along some unknown lines, and probably the final results would have been far different from what they are to-day. The honours of human civilisation are shared equally by the ox and the cow, though the contribution of the horse to its evolution must be considerable. The human race would have been utterly unable to progress from its primitive to its present enlightened state, if the domesticated mammals did not furnish it with meat, milk, butter, cheese, cream, leather and other products or did not draw the ploughs and loaded waggons or did not help groups of population to migrate and colonise.

The explanation of the remarkable growth of cattle population in India is to be found in the peculiar sanctity in which the cow and the ox are firmly enthroned in the Hindu pantheon. But while surmising that these animals may have come to a place of honour from early and poetical association with myths of sun and rain, it is also possible to regard their dignity from a merely human and reasonable standpoint. The paramount importance of protecting and preserving animals absolutely indispensable for the welfare and prosperity of the community might have imposed on its members, otherwise careless of the future, the superlative necessity of treating them as objects of veneration, amounting to religious injunction. Under this reverence for the ox and the cow, which is a sacramental ordinance, they multiplied in the early days of Hindu dynasties before Indian history was changed, when the customary honours for them maintained by formal prescription naturally diminished. In spite of the veneration, sanctioned by centuries of usage and tradition, cows and oxen have not escaped barbarous treatment resulting frequently in permanent dislocations of either their limbs or tails. The fact is that the greater part of Indian teams is not trained, and, being unable to understand the command or being too weak to bear the load, they incur heavy displeasure from their owners.

The improvement of livestock is really a chapter in economic mammalogy, and its problems extend into the fields of genetics, with corridor contacts with the chemistry of animal nutrition and immunology. The Conference has not defined the expression "Improvement" in specific terms, but it may be presumed that the Indian cattle have to be improved all round, producing a race hardy and enduring, with an excellent hide, possessing rich meat, yielding a plentiful supply of milk, and endowed with considerable power of resistance to diseases. These qualities in the local breeds are not to be achieved by crossing experiments alone, for they are only a part of the general science of animal eugenics. The most important problem which confronts the livestock improvement boards must be the source from which fodder has to be obtained for the millions of cows and bullocks which form an integral part of the human society. Mr. Smythies informs us that the forest areas under the Forest Department are only 5 per cent. of the total area of the United Provinces and contribute very little of the grand total of fodder

requirements, since less than one million of all these millions of cattle ever go near the forests. In calculating the total demand for fodder in the United Provinces, he reaches the conclusion that, assuming each head of cattle requires 2 tons per annum, we have to provide 56 million tons of fodder per annum for the whole bovine population. It is easy to have an estimate for the whole Indian team of 200 millions. Closely connected with the fodder problem is the question of supply of fuel to the people who depend upon the cattle dung not only for domestic use but also for the purpose of village industries which require high temperature for their activities. The solution of these immense problems is as difficult as the provision of adequate supply of sufficiently nutritive and wholesome food to the entire human population in India. It is true that an increased supply of fodder per animal can be obtained either by reducing the total number of cattle so as to enable the better fitted ones to get more or by increasing the total supply. In the former case the source of supply of manure and fuel becomes restricted, and in the latter, more land has to be brought under cultivation of fodder grass, which is rendered difficult on account of the increasing demand for extending the zones of rice and wheat cultivation for human consumption.

Far more pressing and important than the quantitative aspect of the problem of fodder supply, is the chemistry of animal nutrition. While we have a reliable body of knowledge of the various proximate principles of food used by man, their physiological reactions and nutritional values, the chemistry of food and nutrition of cattle is still a virgin field. What we have chiefly to consider at present is that the normal affairs in the body of the ruminant animals is not such as may be called a point or a line, but must be regarded as a zonal environment whose superior condition and nutritional well-being can be maintained by the interplay of food and the potential physiological resources of the given individual. Previously chemical researches have shown many instances of highly effective regulatory processes in the body, maintaining physiologically stable conditions, and such automatic regulation is necessary for life processes : but modern investigations reveal that certain quantitative chemical relationships in what is introduced into the animal body may keep the actual condition of the internal environment within the more favourable part of that wider range which the automatic regulatory process permits. We want a precise and carefully tested body of information on the chemistry of the food of cattle and on the physiological reactions evoked by its constituent parts, on which to base the experiments of breeding.

In any scientific plan of breeding experiments, the conditions under which the new race has to live and propagate must inevitably produce an effect favourable or adverse to the interests and purposes of the experimentalist, according as these factors of environment are favourable or hostile for the parents. Further it is a well-established fact that some variations are from the first so stable that their persistence is certain without any precautions of inbreeding. But in other cases it appears to be the experience of breeders that a period of inbreeding with elimination of the undesirable characters that may crop up, serves to fix the desirable ones developing prepotency in their favour. It is true that some stable and important breeds of cattle, for instance, polled Augus, have arisen under conditions involving in the early stages extremely close breeding, and it is well known in horse-breeding that very valuable results have been reached by using the same stallion repeatedly on successive generations.

The whole subject of inbreeding and outbreeding must necessarily underlie a close investigation of the study of the chromosomes of the local races. The results of inbreeding experiments are often puzzling, for they as often fix the desirable qualities as they expose the undesirable characters. The value of exogamy or outbreeding is mainly to introduce a greater variety of raw material on which selective agencies can work. It also promotes "hybrid vigour," by the pooling of diverse hereditary resources of good quality.

Closely associated with the investigations of the chromosomes of the germ cells of the different breeds of cattle in India, is the wider and more difficult problem of the climatic and dietetic

influence on the hybrids. As important or perhaps more important than the breeding experiments of cattle, is the education of the agriculturist and the cattle owner to whom Governments propose to entrust the new breeds produced under their auspices for tending and protecting them.

It seems to us that before launching upon expensive experimental measures, the Government of India may take advantage of the presence of some of the reputed authorities on the science of animal genetics and animal nutrition, visiting India during the next cold weather, for consultation with their own experts on the various schemes devised for the improvement of Indian livestock. To our mind the problems seem most involved, and they have numerous lines of side enquiries, and they have every chance of being hopefully inaugurated, after an extensive and critical examination of their implications by foreign experts whose knowledge and experience in this field of enquiry must be of inestimable value in planning experiments or in obtaining desirable results.

The Production of Food-stuffs, Alcohol and Glucose from Wood by means of the Bergius-Rheinau Process.

By Friedrich Bergius, *Heidelberg.*

THE chemical reaction upon which wood saccharification is based has been known for more than a century. But it is due to technical experiences, gained within the last two decades only, that these chemical possibilities could be put to practical and economical use.

Fundamentally, there are two ways to accomplish the dissolution of the organic substances contained in the wood: the use of dilute acids at high temperatures and corresponding pressures, or the use of highly concentrated acids at low temperatures and pressures.

The former method failed on account of the considerable loss of wood substance, a further disadvantage of this working method being the fact that the sugar is produced in the form of thin solutions. The latter method has thus far proved a failure because of the impossibility of recovering the large amount of acid used.

A method, therefore, which avoided these deficiencies, could only be reckoned with to become a commercial success. For it is essential that an ideal large-scale process transforms practically the whole of the wood treated into usable products and, if the reaction is brought about by means of concentrated acid, recovers most of the latter.

Unlike the endeavours in other fields of chemistry, the chemical methods of treating wood are still rather behind time in regard to the exploitation of the many valuable components contained in this raw material. Due attention is rarely paid to the question of how loss of substance is to be avoided. The reason most likely is that it has not been until relatively late that wood began to be seriously regarded as raw material for chemical processes.

During recent years only, an increased activity is to be recorded on the different fields of wood chemistry in regard to improved working methods and the manufacturing of high-grade final products, though it must be admitted that in most processes a large percentage of the wood is lost during the treatment. Wood distillation, for instance, produces about 60 per cent. of useful materials (35 per cent. of charcoal, 25 per cent. of volatile substances), the balance being lost. The pulp industry recovers about half the wood in form of pulp while the other half is not only lost but has to be eliminated from the process with considerable difficulties. The industries extracting resins and tanning materials from the wood must be satisfied with an even smaller percentage while up to 90 per cent. of the wood can only be used as fuel.

This problem of transforming practically the whole of the raw material into valuable products has been most satisfactorily solved by our own wood hydrolysis process, the so-called Bergius-Rheinau Process.

In painstaking co-operation covering a period of many years, my collaborators and I succeeded in building up the chemical basis of the process and in working out the technique to carry the process through satisfactorily.

Before entering into a description of this process, let me state that, when we began to work on wood hydrolysis, our starting point was not a scientific but an economical problem.

It was the beginning scarcity of food-stuffs in Germany in 1916 that made us turn our attention to a way of alleviating the deficiencies described above by adapting the saccharification of wood to the production of a concentrated and digestible sugar, or mixture of sugars, fit for human consumption in the form of pure glucose or of a highly nutritive carbohydrate to be used as cattle food.

With this end in view, we had to exclude as disintegrating agents dilute acids, which do not allow the production of concentrated sugar solutions, as well as concentrated sulphuric acid. For there is no large-scale method to separate concentrated sulphuric acid from the sugar formed without loss of sugar. As already mentioned, the economy of a process, however, in which concentrated acid is used in large quantities, necessitates the recovery of this acid.

It was for this reason, that we at last chose the chemical reaction, found by Willstätter and Zechmeister a few years before, of dissolving cellulose in 40 per cent. hydrochloric acid, and set to work to develop this reaction into a technical process after we had made sure that a method for the recovery of the concentrated hydrochloric acid could be found. So the working out of this method really has been the first important problem confronting us, and it took us a number of years to arrive at the present method of distilling off the hydrochloric acid under vacuum.

It takes seven parts of hydrochloric acid of 40 per cent. strength for one part of wood to produce the largest possible amount of sugar.

The acid is applied to the wood at normal temperatures. It is essential that an increase of temperature is avoided because heat easily causes the sugar formed to be destroyed.

The economical workability of the process was established beyond doubt only after we had found that a sugar-containing acid-solution is able to react with fresh wood, thereby increasing its sugar concentration, which led us to develop a kind of diffusion process akin to the one used in beet-sugar manufacture.

Working of the Bergius-Rheinau Process.

The process, a diagram of which is given in Fig. 1, is conducted in a battery of diffusers with a capacity of from 20 to 40 cu.m. each, ten of which are joined to one working unit.

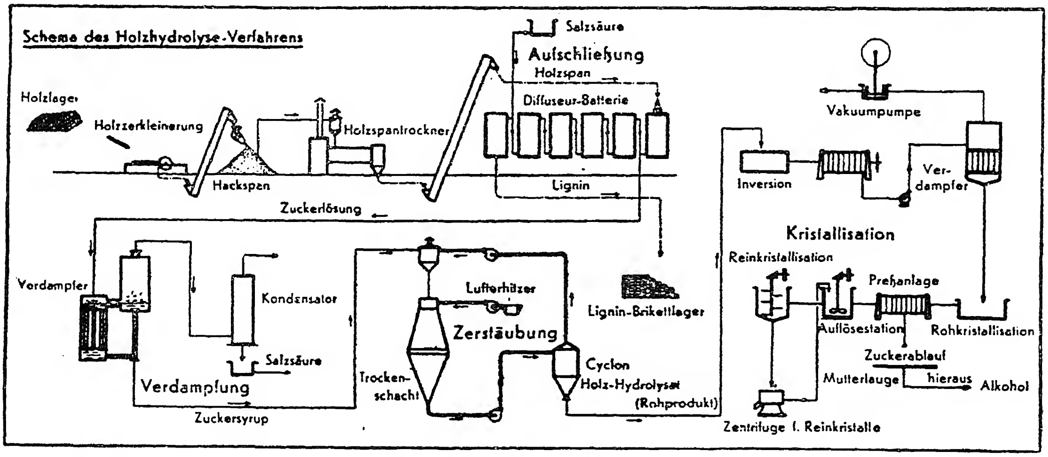


Fig. 1.
Diagram of the Process.

Great difficulties were experienced in building these diffusers so as to resist the corrosive influence of the concentrated hydrochloric acid. From the glass tubes of the laboratory by way of the stone-ware apparatus of the experimental plant and the so-called Prodorite vessels of the semi-technical plant, we arrived at last at the present diffusers built of iron and lined with a special acid-resisting material. After some years of continuous running, these diffusers are not showing the least sign of corrosion.

The wood which normally contains from 20 to 40 per cent. of moisture is first shredded into suitable pieces about the size of a kernel of corn. Saw-dust may be added to this material up to 25 per cent. The wood is then dried in a revolving drum until it contains only about 8 per cent. of moisture.

After treating the wood in the pre-mashing apparatus mentioned with a solution containing sugar and hydrochloric acid, it is dropped in at the top of the first diffuser while the concentrated hydrochloric acid is introduced into the last diffuser entering at the bottom and, after a certain time allowed for the hydrolysis to take place, flowing over into the next vessel and so on, the liquid coming into contact with fresh wood in every diffuser. After having thus passed through the whole battery, it is drawn off from the first diffuser and transported to the distillation plant in form of a 32 per cent. of sugar-containing solution. The hydrochloric acid is brought to the regeneration plant to be recuperated to its former strength by the addition of HCl gas and then returned to the process.

During the treatment, two-thirds of the weight of the wood is dissolved by the acid, and one-third remains in the vessels in form of lignin. After the hydrochloric acid has been systematically washed out, the now neutral lignin is easily removed by opening the vessels at the bottom. The lignin can be used as fuel for the plant, but as it is practically free of ashes, easily briquetted without the addition of a binder and has other special qualities besides, it can be more profitably used for the most varied purposes as will be shown later on.

The next phase of the process is the separation of the sugar from the hydrochloric acid which now, after a number of years of research work, is effected by distillation under vacuum at a temperature of about 36°C. The hydrochloric acid is evaporated and used again after condensation and regeneration. The distillation plant consists of a totally acid-proof apparatus of evaporators with tubes made of a special ceramic material of good heat conductivity (Fig. 2).

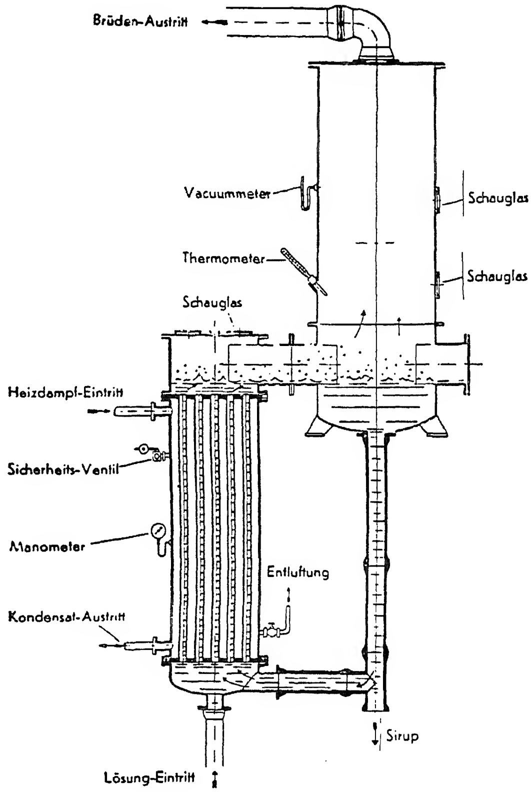


Fig. 2.

Diagram of Tubular Evaporator.

The most difficult problem in constructing this apparatus was finding an arrangement to avoid the dangerous effect of the different heat expansion coefficients of the ceramic and the iron parts. We now have an equipment for the distillation and condensation of hydrocaloric acid under vacuum which operates satisfactorily and can be built in large units. No corrosion or leakage has taken place during some years of running the plant.

After leaving the distillation plant, the syrup, now containing 55 to 65 per cent. of sugar, is dried in a spray diffuser, hot

air being brought into contact with the finely atomized concentrated solution and evaporating the hydrochloric acid and water (Fig. 3).

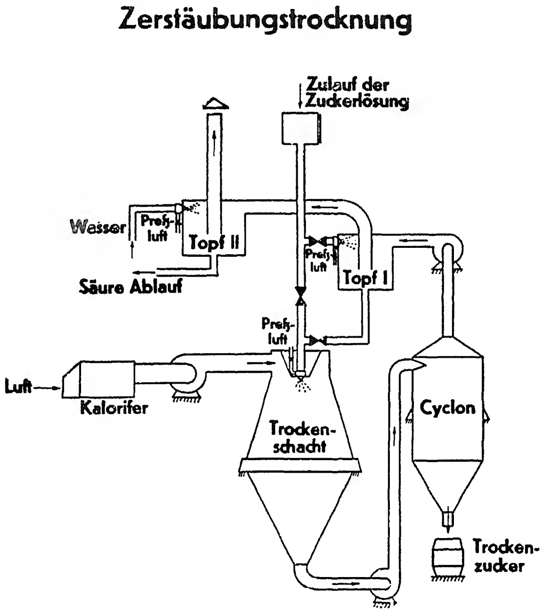


Fig. 3.
Diagram of Spray Drier.

A solid product, containing 1 to 2 per cent. of HCl, about 8 per cent. of water and 90 per cent. of sugars, is collected in cyclons.

At the same time, the acetic acid contained in the wood is distilled and condensed together with the hydrochloric acid. In a special apparatus it is then separated from the latter.

Practically, no loss of sugar occurs during the reaction as every possibility of decomposition due to increase of temperature is excluded.

THE RAW MATERIAL OF THE PROCESS.

The Bergius-Rheinau Process can use every kind and every quality of wood, coniferous wood or wood from foliaceous trees, waste wood from the forests or the waste of the timber industries. Unlike for the production of pulp, the condition of the cellulose fibre is of no account in our process. Whether the wood to be treated is coming from young or old trees, whether it be fresh or stored, sound or rotten, it makes good raw material for our hydrolysis process. The mixture of the carbohydrates produced will, of course, be differently composed the same way as the carbohydrates differ in the wood before undergoing treatment. The output of alcohol or crystallised glucose, however, is not to any considerable extent influenced by these differences in composition.

The Bergius-Rheinau Process can be conducted according to the chemical components of the wood to be treated. Wood with a large amount of resins or tanning substances will be treated with suitable solvents before submitting it to the hydrolysis process. The pentosanes of the wood of foliaceous trees likewise are first extracted by means of dilute acids.

In most countries, the raw material of the process is to be had in abundance. India's forest area, for instance, is about 80 millions of hectares, *i.e.*, 27·5 per cent. of the total land area, about the same percentage, by the way, as in Germany.

THE PRODUCTS OF THE PROCESS.

The solid raw sugar, the primary product of the process, contains—depending on the sort of wood used—glucose, mannose, xylose, galactose and fructose, mainly in tetrameric form. Polymerisation from the monomeric to the tetrameric form takes place in the run of the process between the diffusion battery and the spray drier. The total yield of the different sugars amount to from 60 to 66 per cent. of the original dry wood substance, thus practically equalling the theoretically possible output.

By means of an inversion process, these sugars can easily be transformed into a fermentable solution.

The dry wood sugar, a pure carbohydrate, can, after neutralising the small amount of acid with lime, be used as fodder—especially for pigs and poultry—either by itself or in mixture with other fodder such as barley or dried potato chips. Extensive tests carried through by official institutions over prolonged periods, proved the fact that the feeding value of this raw wood sugar is equivalent to that of barley.

Containing a small percentage of hydrochloric acid, the dry wood sugar, as has been found by experts, is an exceedingly effective means of securing the preservation of green fodder in soils.

By the usual fermentation process, alcohol can be produced from the wood sugar. 200 kilograms of raw wood sugar yield 100 litres of pure 100 per cent. alcohol, *i.e.*, about 50 liters per 100 kilograms of reducing sugar.

The xylose contained in the sugar solution cannot be fermented by employing yeast, and galactose can only be fermented under special conditions. They remain in the spent wash which in being used over again is more and more enriched. The wash is then evaporated and the residue dried in a spray drier into a stable product without the addition of mineral acids. This product can also be used as cattle food or for other purposes.

By this method, about 80 per cent. of the raw sugar are converted into alcohol while the remaining 20 per cent. are recovered as other useful material.

It is obvious that the raw wood sugar can also be used for other fermentation processes yielding, for instance, baker's yeast or fodder yeast and lactic acid. From 100 kilograms of fermented sugar, 50 kilograms of dry yeast containing about 55 per cent. of albumen are produced. Accordingly, 25 kilograms of dry yeast containing about 13 kilograms of albumen are obtained out of 100 kilograms of wood.

About one-third of the raw wood sugar can, by an inversion—and crystallisation—process, be transformed into chemically pure crystallised glucose or crystallised xylose, the former being the more important of the two. The inverted raw sugar solution is neutralised, filtered and concentrated and can then be easily crystallised. By re-crystallisation, a white and very pure dextrose is obtained.

The mother-liquor, still containing some glucose, mannose and other sugars, can be fermented or used as fodder. In this way, no sugar is lost. By a special method of conducting the process, xylose also can be recovered in crystallised form.

Out of the xylose solution, furfural, a high grade solvent for refining resins or crude oil, can be produced. It can also be used for the production of artificial resins and organic acids or transformed into other solvents of special properties.

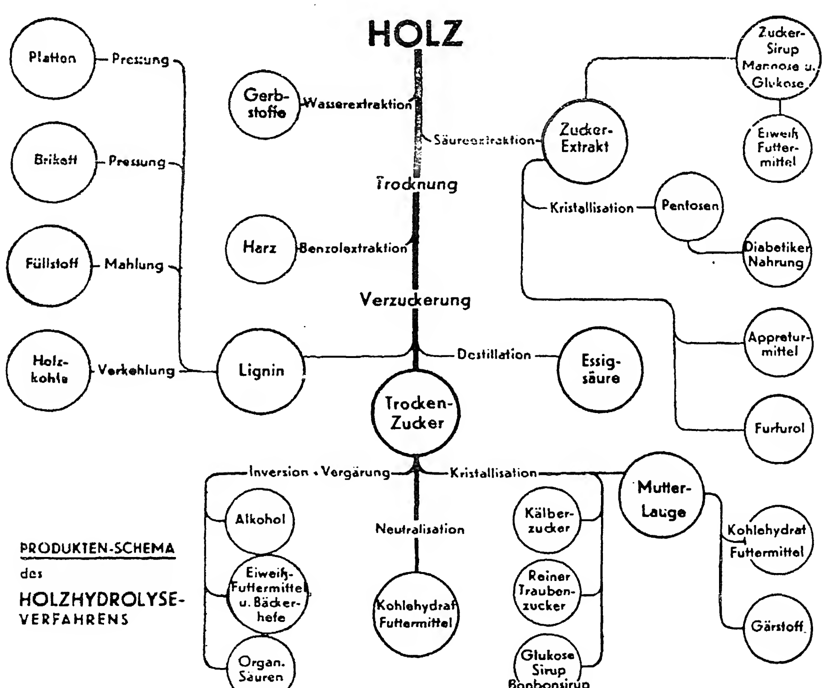


Fig. 4.

Diagram of the Products.

Besides the products mentioned, a number of others can be produced from wood sugar, for instance, some special kinds of sugar for pharmaceutical and different technical purposes, glycerin, tanning substances and resins.

By-Products.

Lignin, one of the by-products of the process, consisting of the non-hydrolysable substances of the wood, is produced to the amount of 33 kilograms per 100 kilograms of dry wood substance. As has been mentioned, it can be used for the most varied purposes. Briquetted lignin, for instance, can be turned into a hard and uniform charcoal of good quality and both, lignin briquette and lignin charcoal, being free of acetic acid, are suitable fuels for the modern wood-gas generators.

The other by-product of the process, acetic acid, is recovered to the amount of 2 per cent. when treating coniferous wood and of 5 per cent. when treating wood from foliaceous trees. Technical acetic acid is not only used as solvent and raw material for the production of esters but for various other purposes.

A diagram of the products obtained by the Bergius-Rheinau Process is shown in (Fig. 4).

In judging the economic value of the process, the fact that it recovers, as has been shown, nearly 100 per cent. of the wood treated in form of valuable products, is of considerable importance.

Food Adulteration in the Madras Presidency.

By Herbert Hawley, M.Sc., F.I.C.
(*Government Analyst for the Madras Presidency.*)

I PROPOSE to give some account of the working of the "Prevention of Food Adulteration Act in the Madras Presidency". It is a fact that very little information is published as to the working of this and similar Acts in other provinces, and I hope that this short account of the working of the Madras Act may induce Government analysts in other provinces to give a similar account of their activities in their own areas. There is plenty of information available on the working of the Food and Drugs Act in England. All public analysts there are under statutory obligation to publish quarterly reports; in practice most of them publish annual reports as well and preces of these can be found in many scientific journals.

If the reports of analysts in India could be studied, it would be found that the position is entirely different from that of England. In England, analysts usually report some small percentage, say 3 to 5 per cent. of their samples as adulterated. But, if one comes to look further into the matter, one finds that the bulk of this adulteration is due to the infringement of certain rules that have been prescribed in the interests of public health, *e.g.*, certain preservatives in food are prohibited; others may only be used to preserve specified foods and then only subject to a maximum proportion being used. Gross adulteration by shop-keepers, for example, the mixing of margarine (imitation butter) with butter is almost non-existent. In India,—I can only speak for Madras, but I imagine that other provinces show similar results—gross adulteration of staple articles of food is met with in every area in which the Act is worked. The Madras Act is in force in about 60 local areas including the City of Madras. Between 6,000 and 7,000 samples a year are examined and of these more than a third are found to be adulterated. During last year in the Madras Presidency, of 6,581 samples taken the percentage of adulteration was 67·2% in milk, 33·1% in ghee and 10·9% in oils.

Bad as the figures are for ghee and oils, they show a definite improvement on previous years, and one looks forward with some confidence to some further improvement. This is due to a change in policy

in dealing with food adulteration. When the Act was first brought into force seven years ago, it and the Regulations made under it, were based on the English Acts. Thus fairly complicated regulations were prescribed for the labelling of commodities which the vendors wished to sell as mixtures. The Regulations also prescribed that when a vendor was selling such an article to an illiterate, he must give the same information by word of mouth. In practice these regulations were a complete failure. It became the practice of ghee merchants to label all their vessels with a notice stating that they guaranteed some trivial proportion of ghee, usually 3 or 5 per cent. As it was obvious by mere taste or smell that actually a large proportion of ghee was present purchasers accepted the vendor's explanation that these labels were meaningless and were simply displayed to meet the requirements of the Regulations. In this way heavily adulterated ghee could be sold as genuine ghee. Similar difficulties arose in connection with gingelly oil which was at one time very heavily adulterated with the cheaper groundnut oil. The requirement that these notices should be explained to illiterates was completely ignored and it was found difficult to obtain witnesses to substantiate a prosecution for infringing the rule. The adulteration of ghee and gingelly oil is now prohibited and mixtures may not be sold or stored for sale under any designation. This rule has been in force for more than a year in connection with oil and adulteration has fallen from 28% in 1933–34 to 11% in 1935–36. A similar rule for ghee was in force for 9 months during the last year for which complete figures are available and ghee adulteration which was at one time as high as 53% fell to 33%.

Milk adulteration remains steady at a very high figure. As milk is sold very largely by itinerant vendors, who, following a conviction, will usually change their district, it is not possible to drive a persistent offender out of business as is possible with residential shop-keepers. I have recommended to Municipalities that they should adopt by-laws requiring registration of milk hawkers whose licence would be liable to withdrawal following a conviction. If my recommendation is accepted it will be interesting to see whether it causes an improvement.

Though the Madras Act can be applied to all food-stuffs I have recommended sampling officers to confine themselves, for the time being, to staple articles of food such as milk, ghee, butter and gingelly oil, and these commodities make up a large proportion of the samples examined here. I propose to give a few notes as to the methods of analysis used in connection with these and a few other commodities and the prescribed standards, where they exist.

Milk.—Under the rules it is laid down that buffalo milk should contain at least 9·0% solids-not-fat and 4·5% fat and cow milk 8·5% solids-not-fat and 3·0% fat. There are supplementary standards for nitrogen of 0·53% for buffalo milk and 0·5% for cow milk. These latter standards are intended to be used when decomposition takes place and it is not possible to estimate the proportion of solids-not-fat orginally present with any accuracy. When a sample is decomposed it is treated with a few drops of strong caustic soda, warmed, and mixed. It is then easy to get uniform sample and it has been found that the proportions of fat (estimated by Rose Gottlieb) and nitrogen in such a sample are, for all practical purposes, identical with those in the original milk. In connection with the Madras standards it should be noted that, as with all similar standards, all they do is to transfer the onus of proof of adulteration to the Analyst when the sample complies with the standards. With heavily adulterated samples the proportion of adulteration is calculated from the deficiency below the standard figures, but in the case of border-line samples either above or below the standard, freezing point determinations are made with the Hortvet Cryoscope. This of course gives an exact figure for the proportion of added water, and it is frequently found that samples which by comparison with the standards would be passed as either genuine or but slightly adulterated or actually heavily adulterated. This arises from the fact that milks, and buffalo milk in particular, frequently contain 10 or even a higher percentage of solids-not-fat. When we commenced freezing point determinations one minor difficulty had to be overcome. In Madras, Inspectors are instructed to add a small quantity of formalin (40% formaldehyde) to their samples

to preserve them in transit. Formaldehyde has of course a very low molecular weight and accordingly quite small quantities have a very large effect on the freezing point. To remove the formalin, our procedure is as follows :—About 90 mils. of milk and about 10 grams of paraffin wax (to minimise frothing) are placed in a distilling flask which is counterpoised. About 40 mils. of water is then distilled off. The flask is cooled and brought back to its original weight with water. It is found that all free formalin comes off in the distillate. The residual milk will, on acidification, give colour tests for formalin, but this residual formalin appears to have condensed with the proteins of the milk as it is found that milk evaporated and brought back to its original weight in this way has a freezing point almost identical with that of the original milk.

Ghee and Butter.—In Madras there is a limit of 20% of moisture for butter. The determination of moisture is, of course, analytically very simple. On the other hand, it is laid down that butter and ghee must be prepared exclusively from milk or cream, and further the addition of foreign fat to either commodity is prohibited. To express a confident opinion as to whether a sample of ghee (the same thing applies to butter-fat) is genuine, frequently involves a very large amount of work. Though ghee has an average Reichert value of about 32 or 33 many samples give figures as high as 40; on the other hand, even bulked samples can give figures as low as 28. *N.B.*—In these notes I am ignoring ghee prepared from the small yield of milk given by buffalos which are nearing the end of the period of lactation. From such samples very low figures can be obtained, but, in view of the relatively small yield, the presence of one or two such animals in a herd will have very little effect on the figure for the bulked sample.

When the Act was first introduced samples were normally either unquestionably genuine or heavily adulterated and in the majority of cases a Reichert determination alone was sufficient. The position has now changed entirely. The ghee merchants themselves employ semi-skilled chemists who can make routine analyses, such as the determinations of Reichert Values and Refraction, and who are competent to advise their employers as to the preparation of mixtures which will give the maximum probability of the sample being classed as "border-line" and passed as genuine. In these circumstances and in view of the great variability in the figures for Reichert Value and Refraction, it is obvious that no sample can be passed as genuine without further investigation unless it yields a Reichert of over 30; and even in these cases some further investigation should be done if there is any appearance of lack of correspondence between the Reichert Value and the Refraction. The supplementary figures I rely on mainly are titre of the insoluble fatty acids, melting point of the sterol acetate and a determination of *iso*-oleic acid. An adulterant, which has recently come into popularity is a very much hardened hydrogenated fat. I believe this is popular because it has a lower refraction than the ordinary vegetable fats of moderate consistency. It is also a fact that, due to the high degree of hydrogenation, most of the sterol has been destroyed. Accordingly, if a sample of buffalo ghee having a high Reichert Value is adulterated with a small amount, say 20% of such adulterant, the fact of adulteration will not be detected by the Reichert, Refraction or melting point of the sterol acetate. On the other hand, this particular form of sophistication is easily found out by a determination of the titre of the insoluble fatty acids. The Titre figure for genuine samples of ghee normally lies between 40° and 42°. Figures over 42°·5 are very rare and I have yet to meet a sample with a titre exceeding 43°. On the other hand, the adulterated samples usually give a titre of over 43° and figures up to 45° have been recorded. If, when the presence of this adulterant is suspected, the titre gives a border-line figure, it becomes necessary to determine the proportion of *iso*-oleic acid before one can give a definite opinion. Ordinary vegetable fat of the consistency of genuine ghee increases the Refraction considerably and if this increase is not high enough to be conclusive one can give a definite opinion after determination of the melting point of the sterol acetate, as these substances contain a considerable proportion of phytosterol. The highest melting point obtainable after repeated crystallisation of cholesterol

acetate is 115·2; but using the digitonin method and recrystallising only twice, one normally obtains a figure of 116 or higher when 15 or 20% of vegetable fat is present. This test is, of course, absolutely conclusive, as phytosterol does not occur in animal fat. A note describing the method I use for the preparation of the sterol acetate was published in the *Analyst* of September 1933, page 529. The manipulations involved in this test are not easy. The digitonide must be very carefully prepared and the final product amounts to no more than a few milligrams, the melting point of which has to be determined with great precision. The test should not be entrusted to any one but a highly skilled chemist.

It should be noticed that butter is quite as commonly adulterated as ghee and that those members of the public who believe that they are protecting themselves when they have their ghee made from butter in their presence are living in a false paradise.

In some provinces so-called standards have been prescribed for ghee and butter-fat. These usually include a minimum Reichert Value but sometimes figures for Refraction, Saponification value, etc., are included. On my advice no such standards have been prescribed in Madras; I believe them to be worse than useless. Owing to the variation of the figures given by genuine ghee it necessarily follows that there must be many adulterated samples which would satisfy standards based, as such figures must be, on minimum values, and, in such cases, to counter the presumption of genuineness it is necessary for the analyst either to attend Court or to give a lengthy explanation in his certificate which, though understandable to a chemist, can only confuse the mind of a lay Magistrate. I am assuming that no responsible chemist would allow himself to be converted into a kind of chemical sorting machine, passing or condemning samples according as they are inside or outside the prescribed minimum limits.

Oils.—In the Madras Presidency the most popular oil is gingelly oil. This is commonly adulterated with groundnut oil. The estimation is very simple. It is carried out by the method of Franz and Adler, as quoted by Evers in his paper on the determination and estimation of arachis (groundnut) oil, *Analyst* 1912, page 488. Genuine gingelly oil, by this method gives a turbidity at 20°C., arachis at 40° and as the increase in the temperature of turbidity is directly proportional to the amount of arachis oil present it thus supplies a figure from which the latter is easily calculated. Recently a number of samples of coconut oil have been found to be heavily adulterated with mineral oil.

Tea.—Standards for tea are similar to those in other provinces. Their effect is to prohibit foreign leaf and excess amounts of dust and sweepings. At one time tea was heavily adulterated. Now the great majority of samples are genuine. This is probably due to the activities of the Tea Cess Committee which include not only propaganda but also the sampling and examination of a large number of samples.

A common adulterant of tea dust is black gram husk. Leaf tea has been adulterated with foreign leaf. For microscopic examination the tea is boiled with a small quantity of 10% sodium hydroxide and then washed by decantation with hot water. Under the microscope the structure of the leaf then becomes quite clear. The husk of black gram is easily identified by its characteristic appearance. Husk is estimated by the ordinary methods which will be found in text-books under pepper. When foreign leaf is present a determination of caffeine is necessary.

Coffee.—Coffee is largely adulterated. The commonest adulterants are chicory and Bengal gram. Chicory is estimated by text-book methods. Bengal gram is easily identified under the microscope after the sample has been cleared with sodium hydroxide. To estimate it a determination of caffeine is necessary.

The Occurrence of Mica-Pegmatites around Gurpa, Gaya.

By M. P. Bajpai.

(*Geological Laboratories, Benares Hindu University.*)

SEVERAL veins of mica-pegmatites occur near Gurpa, a small railway station on the Grand Chord line of the East Indian Railway, about thirty miles south-east of Gaya. The veins were first noticed by the author in 1931 and a paper, "On the occurrence of Mica at Gurpa, Gaya" was read before the Geological Section of the Indian Science Congress at its Calcutta session in January 1935. Recent work on these pegmatitic veins has definitely established the presence of marketable mica in them. A brief description of the area is given below. Granites, gneisses, quartzites, mica-schists and an amphibole schist are the chief "Country" rocks of the area. Among mica-schists a quartz-muscovite schist is of common occurrence. It consists wholly of quartz and muscovite, the former predominating over the latter. Granites and gneisses form nearly all the conspicuous hills of the country, the Gurpa hill being the most prominent.

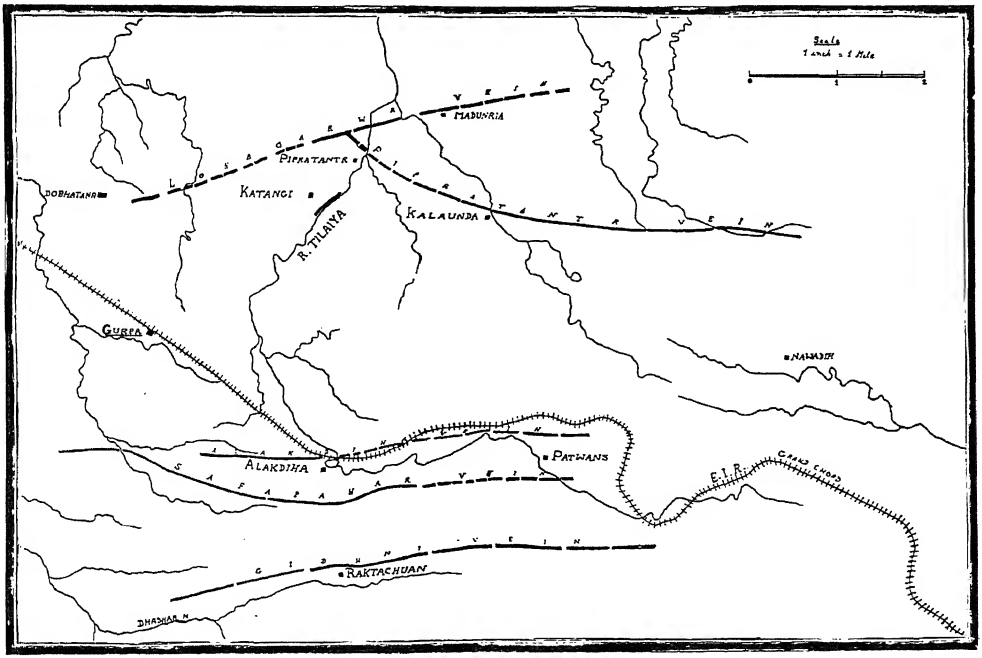
The country rocks are traversed by mica-bearing veins, of which five are more important. For the sake of description these five have been given the following names :—

South of the Railway line
1. The Gidhni vein
2. The Safa Pahar vein
3. The Alakdiha vein

North of the Railway line
4. The Lohagarwa vein
5. The Pipratantr vein

VEINS SOUTH OF THE RAILWAY LINE.

(1) *The Gidhni Vein.*—Several small veins and lenticular masses of mica-pegmatites running east-west occur in the southernmost part of the country. Some of them are found at the top of the hill range which marks the boundary between the Hazaribagh and the Gaya Districts, while others are found at the foot and on the slopes of this range. They occur either along the broken line shown on the map or a little to its left



Map of the Country around Gurpa showing the Distribution of Mica-bearing Pegmatites.

or right. Probably, all these outcrops are connected with one another and some of them form parts of the same vein. Quartz-muscovite schist and biotite granite are the predominating "Country" rocks in this part of the area. Only those pegmatites are rich in mica which traverse the quartz-muscovite schist. A trial pit was sunk at the top of the Gidhni Hill near the contact of the pegmatite with the quartz-muscovite schist. At a depth of about 35 ft. several good samples of ruby mica measuring up to 30 sq. in. were obtained. Generally the plates are very lightly stained.

(2) *The Safa Pahar Vein.*—The vein was first observed in a level country west of the Safa Pahar. It was traced eastwards for a distance of about four miles. It runs through the Safa Pahar in the form of several ramifying branches containing no mica. After traversing the Safa Pahar it again outcrops in a level country for some distance, and probably extends upto the village of Patwans. From a trial pit about 20 ft. deep west of Safa Pahar good plates of green mica measuring upto 14 sq. in. were obtained.

(3) *The Alakdiha Vein.*—A well-exposed outcrop of this vein is seen in a level country west of the Alakdiha Dam. West of the dam it was traced for about two miles. On the east an outcrop of pegmatite was seen in the northern outskirts of the village of Patwans. The trend of this outcrop suggests that, probably, it forms the eastern extension of the Alakdiha vein. This vein also contains green mica. The plates are lightly stained and measure upto 20 sq. in.

VEINS NORTH OF THE RAILWAY LINE.

Besides the Lohagarwa and the Pipratantr veins several pegmatite lenses occur in the bushy jungle east of the Tilaiya Nala. A small vein runs along the Nala on its left bank about a quarter of a mile east of Katangi.

(4) *The Lohagarwa Vein.*—For the greater part of its length it runs under alluvium and it is only at a few places that it is exposed at the surface. Its best exposure is seen near the confluence of the Kalaunda stream with the Tilaiya Nala, where it traverses mica schists. East of Madnuria it cuts through granite and contains no mica. Recently a mine has been opened about a mile north of Lohagarwa. It has already been worked successfully upto a depth of about one hundred feet. The grades of mica plates which are amber coloured vary from Mica No. 2 to No. 7.

(5) *The Pipratantr Vein.*—The best exposure of the vein is near Pipratantr where it crosses the Tilaiya stream. Here it is above 100 ft. wide and cuts through gneisses and schists. South-east of the village of Pipratantr it is concealed by alluvium for some distance. A tributary of the Tilaiya exposes it near Kalaunda. East of this village it cuts through granite and is seen running on the northern slopes of the Kalaund-Labni Hills for a few miles. West of the Tilaiya Nala it again gets covered up by the alluvium. It contains ruby mica of good quality. A mine has been opened near Pipratantr on the left bank of the Tilaiya stream. The output of mica from this mine is very satisfactory.

Besides the pegmatite veins described above, several apophyses occur in the country forming a sort of network at several places. The thickness of the veins varies from a few feet to more than a hundred feet and no vein maintains a uniform thickness along its course. This is due to the occurrence of several lenticular masses of mica-pegmatites in the same vein. In the veins these lenses of pegmatite are connected with one another either by a narrow band of pegmatite itself or by that of quartz.

Numerous facilities for mica mining can be had around Gurpa. The greatest advantage, which the area offers, is easy transport, as the veins lie close to the Gurpa Railway Station. The adjoining forests abound in good sal-timber and skilled labour is available in the neighbouring villages. The results of trial pits, the profitable working of the two mines which have been opened in the area, the good quality of mica and the facilities for mining available in the neighbourhood, point to a promising prospect of mica-mining in the area.

According to Holland,[1] the Bihar mica belt extends from Jhajha to Bendi (Hazaribagh District) in the west, while

[1] *Mem. G. S. I.*, **34**, Pt. 2, 45.

Fermori[2] states that Chauparan is the western limit of the belt. The Gurpa mica field lies to the west and north-west of Bendi, the distance between Bendi and the western limit of the Gurpa field in its southern part being about ten miles. The north-western face of the area is about 14 miles to the north of Chauparan.

With a view to determine the suitability of the felspar of the Pipratantr vein for use in ceramic industries a specimen from the left bank of the Tilaiya Nala near Pipratantr was analysed for its iron and alkali contents. It was found to contain 0·07 per cent. of Fe_2O_3, 12·85 per cent. of K_2O and about 4·08 per cent. of Na_2O. Experiments made in the Department of Ceramics of the Benares Hindu University show that the felspar is of good quality and can be used in glass and ceramic industries.

[2] *Rec. G. S. I.*, **53**, Pt. 3, 288.

OBITUARY.

Mr. J. H. Field, M.A., C.S.I.

THE death of Mr. J. H. Field, M.A., C.S.I., is a great loss to Meteorological Science. He was the Head of the Indian Meteorological Department from 1924 to 1928.

Before Mr. Field entered service in India in 1904, he had already achieved distinction during the Boer War by devising an automatic alarm fence which, on contact, lit flares and rang alarms in block houses. In order to gain first-hand information of the intricacies of upper air soundings, he undertook a balloon voyage at Lindenberg and also learnt the technique of kite flying. At that time Mr. W. H. Dines had just started his, now famous, upper air investigations in England and Mr. Field was not slow to realise the value of this important work. He devoted some time with Mr. Dines to gain an insight into the problems of the upper air. It is probably correct to say that in India Mr. Field was the first to send up kites fitted with temperature and humidity recording instruments. In 1905, while testing his kite-winch machines at Karachi, Mr. Field discovered that above the surface layer of moist air in that region there was a dry and warm current. During the next two years, kite experiments were undertaken at Belgaum. Mr. Field was not satisfied with these desultory observations and took short leave for a voyage across the Bay of Bengal with a view to carry out upper air soundings in that great laboratory of Indian cyclones. It was always a pleasure to listen to the various anecdotes of his quaint experiences while flying kites at various places.

Mr. Field, as a born experimentalist, had to struggle hard between his own natural inclination of working in laboratories and workshops and the high sense of administrative responsibility as an officer of the Department. He, however, never could forget his ideal, namely, upper air research and amid his less interesting adminstrative duties managed to improvise a small workshop in Simla. In this ill-equipped place he designed some very light recording instruments for use with his kites. This was a noteworthy achievement. He also overcame serious difficulties in the measurement of winds in higher altitudes under Indian conditions. The rubber balloons used in Europe rapidly deteriorated in the tropics. After a very patient testing of various kinds of materials he substituted gutta-percha and celluloid balloons in place of rubber. His activities, however, were perforce limited on account of financial difficulties, as the Government in those days was not in a position to realise the importance of upper air research. Things looked very gloomy indeed and between 1910–12 Mr. Field, in sheer despair, was seriously contemplating resignation. It was chiefly through the good offices of the Royal Society through the Secretary of State for India, that eventually three lakhs of rupees were sanctioned specifically for upper air research and Mr. Field selected Agra as the venue for his experimental and investigational activities. This is the history of the establishment of the Ærological Observatory at Agra in 1914 with Mr. Field as its first Director. It was here that his special aptitude for

experimental work found full scope and Mr. Field laboured incessantly for a decade to adapt experimental methods of the West to suit Indian conditions. It is to him that we owe the splendid collection of standard meteorological data of the upper layers of the free atmosphere over India. His investigations on the relation between the monsoon and the upper winds and the standard exposure of instruments in India will long be remembered in the meteorological history of India.

Mr. Field's activities were interrupted by the Great War during which he went to Britain and joined the Admiralty Research Station at Shandon, Scotland. Here he designed an electrical depth recorder for paravanes on mine sweepers. After the conclusion of the War, Mr. Field returned to India and resumed his upper air investigations. In 1922 his services had to be requisitioned in the Director-General's Office at Simla. Mr. Field knew that his duties would be mainly administrative but did not flinch. On the contrary he brought with him his impressive enthusiasm and convincing advocacy to lubricate the adminnistrative machine at Simla. Mr. Field's predecessor in the Office of the Director-General was Sir Gilbert T. Walker, a mathematician of repute. Under Sir Gilbert's direction the mathematical and physical work done in the India Meteorological Department had received world-wide recognition. It was in the fitness of things therefore that, after the retirement of Sir Gilbert, the mantle of the Director-Generalship fell on Mr. Field, a born experimentalist.

Mr. Field did not relinquish his meteorological work even after his retirement. His services were requisitioned by the Air Ministry, London, to investigate the cause of the so-called "Gibralter plume". In this work also he exhibited his characteristic thoroughness and foresight by preparing a clay model of Gibraltar and experimenting with it in a wind tunnel before proceeding to determine the characteristics of the wind circulation on the spot.

His example has been a constant source of inspiration to the staff of the India Meteorological Department who received such guidance in a critical time of intense activity as financial facilities allowed. For this service alone the Indian Meteorologists can never be sufficiently grateful to him. The India Meteorological Department will ever remain indebted to Mr. Field for the tireless patience and critical acumen which have characterised both his scientific and administrative activities.

Nanga Parbat Expedition, 1937.

As we go to the press, our attention has been drawn to an Associated Press message dated June 20th, concerning the ill-fated Nanga Parbat Expedition which was overwhelmed by an avalanche. Eight of the nine climbers, including the intrepid mountaineer leader Dr. Wien, perished. Nine Gurkha porters are also reported to have been killed. The news of the disaster will be received with the greatest dismay; the mountaineer experts opine that the season was not propitious for the ascent of the peak which is considered more accessible in autumn.

Two unsuccessful attempts on Nanga Parbat (26,629 feet) have been recorded. The first of these was made in 1895, and the second in 1934. The latter was led by Willi Merkl. The present expedition arrived in Bombay on April 30, and established their base camp at an altitude of 10,650 feet on May 18. Camp 2 was reached on May 25 but owing to the unfavourable weather conditions the climbers had soon to return to the base camp. Weather having improved they proceeded rapidly reaching camp 2 on June 3, camp 3 on June 4 and camp 4 on the next day.

The porters all belonged to the Himalayan Club and had been on several expeditions including the Everest.

The members of the ill-fated expedition included Prof. C. Troll and Dr. H. Hartmann, eminent geologists who proposed to collect scientific data during the climb.

LETTERS TO THE EDITOR.

Some New Features in the Activated Accumulation of Solute Molecules at Surfaces of Solutions.

When the surface of a solution of benzopurpurin is allowed to age, an adsorption film develops which has some properties similar to those of the films of insoluble substances studied by Langmuir, Adam and others. This novel phenomenon, first observed in this laboratory[1] has been successfully interpreted as a case of activated accumulation.[2] The same phenomenon has later been observed by McBain and Wilson with soap solutions[3] and by Florence, Myers and Harkins with lauric acid solutions.[4] The present author has continued the experiments on the rate of accumulation and the time-variation of surface tension with solutions having different concentrations of benzopurpurin from M/625 to M/5,000. The results disclose some new and interesting features of the phenomenon. First, the application of Langmuir theory of adsorption to the process of accumulation shows that the solute molecules in the adsorption film try to remain whipping and whirling whenever there is enough free space to do so, thereby increasing their sphere of action in inhibiting accumulation. The effect of varying the concentration is also of interest. In the more dilute solutions, there is a rough proportionality between the rate of accumulation and concentration. At higher concentrations, however, there is an abnormally high enhancement in the rate of accumulation which is possibly to be connected with the polymerisation of the dyestuff. The study of the variation of surface tension with time (by the new technique described by the author[2]) of an M/1,000 solution of benzopurpurin shows a behaviour similar to that exhibited by the lauric acid solution,[4] with a few differences. The surface tension falls sharply (though only to a small extent) in the first instance, falls slowly thereafter for half an hour, then falls rapidly for the next half hour and finally tends to attain the equilibrium value. The details of these observations as well as their interpretation will shortly be published elsewhere.

K. S. Gururaja Doss.

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[1] Doss, *Curr. Sci.*, 1935, **4**, 405.

[2] Doss, *Proc. Ind. Acad. Sci.*, 1936, **4**, 97.

[3] McBain and Wilson, *J. Am. Chem. Soc.*, 1936, **58**, 380.

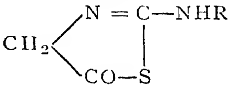
[4] Florence, Myers and Harkins, *Nature*, 1936, **138**, 406.

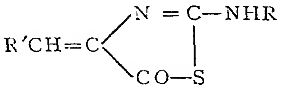
Influence of Double Bond on the Stability of Heterocyclic Compounds.

Ingold[1] brought forward evidence to show that the presence of a potential semi-cyclic double bond, whilst hindering the formation of smaller rings, should promote that of seven- and eight-membered carbon rings. It has been thought worthwhile to examine, in a number of cases, how the stability of a heterocyclic compound is influenced by the introduction of a double bond just outside the ring.

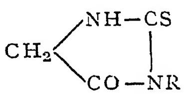
It is now observed that the introduction of a double bond just outside a heterocyclic ring of the type (I) decreases the stability of the ring. The thiazole (I) condenses

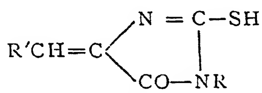
with aldehydes to furnish the compound (II).[2] Both these compounds are hydrolysed by alkali to the corresponding acids. A comparative study of the rate of hydrolysis definitely shows that the compound (II) is less stable than (I).


(I)


(II)

In contrast to the above observation, it has previously been found[3] that the compound (IV), obtained by the condensation of the thiohydantoin (III) with aldehydes, is much more stable towards alkali than (III). It was further observed that, although the thiohydantoin (III) exists in the thio-thiol tautomeric forms, the compound (IV) exists only in the thiol form. This observation shows that, in all probability, a relationship exists between the internal strain in the ring (IV) consequent upon the introduction of a double bond just outside the ring and the tendency of the ring to acquire a double bond for becoming stable.


(III)


(IV)

My thanks are due to Prof. P. C. Guha for his kind interest in this investigation.

TEJENDRA NATH GHOSH.

Department of Organic Chemistry,
Indian Institute of Science,
Bangalore,
June 6, 1937.

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[1] *J. Chem. Soc.*, 1921, **119**, 309.

[2] Ghosh, *J. Ind. Chem. Soc.*, 1937, **14**, 113.

[3] Ghosh, *ibid*, 1934, **11**, 26–27.

6-Aceto-7-hydroxycoumarin.

THE condensation of resacetophenone with malic acid and sulphuric acid has been described by Aggarwal and Dutt[1] who obtained in this reaction the substance figures in the title. Ray, Vaid and Silooja[2] have indicated the formation of this substance in very small yield by the Fries' migration of 7-acetyloxycoumarin. Joshi[3] has described this compound in detail.

The condensation of resacetophenone, malic acid and sulphuric acid at all temperatures between 90–130° gives 7-hydroxycoumarin by the extrusion of the aceto group from the nucleus, a fact which we have established by a mixed m.p. determination with an authentic specimen. At lower temperatures, the only isolable product is unchanged resacetophenone, which as isolated from the reaction mixture melts at 139° instead of 142°. The substance described by Dutt and Aggarwal also melts at 139°. This substance shows no lowering in m.p. when mixed with a genuine specimen of resacetophenone. It may be stated that resacetophenone requires C, 64·0% whilst the substance m.p. 139° was found to have C, 64·5%. This fact also supports the view that the compound described is impure unchanged resacetophenone.

K. N. GAIND.
S. K. GUPTA.
J. N. RAY.

University Chemical Laboratories,
Lahore,
May 20, 1937.

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[1] *J. Ind. Chem. Soc.*, 1937, **14**, 109.

[2] *J. Chem. Soc.*, 1935, 813.

[3] *Proc. Ind. Sci. Cong.*, 1937, Hyderbad Session.

Enzyme Method for the Estimation of Adrenaline from Suprarenal Glands.

ADRENALINE, the active principle of the suprarenal glands, owing to its ease of oxidation by oxidising agents, has given rise to a number of methods for its analysis. It has been observed that the oxidase prepared from the seeds of *Dolichos lablab* has the property of oxidising adrenaline to a red coloured compound and based on this observation a colorimetric method has been developed for its assay. Recently Blaschko, Richler and Schlossmann[1] decteted the presence of adrenaline oxidase in liver and kidney of rats, rabbits and guinea-pigs.

During the course of investigation on the action of the oxidase on adrenaline, it was observed that (1) colour formation takes place between pH 4·4—7·6 and the colour is more stable in the acid range, (2) colour develops within 20 seconds, and (3) a good proportionality exists between different concentrations of adrenaline, and the intensities of colour developed.

The method was applied for the estimation of adrenaline in fresh suprarenal glands.

Fresh glands from dogs and monkeys were extracted with N/10 HCl. and proteins precipitated by the addition of 10% sodium acetate and heating. The solution was filtered and the filtrate made up to a known volume. 5 c.c. of the solution was mixed with 2 c.c. of M/2 phosphate buffer (pH 6·0), 3 drops of 1% H_2O_2 and 2 c.c. of enzyme solution. The colour developed within 1 minute, which was then compared with the standard. Results obtained by the enzyme method were then compared with those obtained by the blood-pressure method. Table I incorporates the data.

TABLE I.

Animals		mg. of adrenaline per 1 gm. of fresh gland	
		Enzyme method	Blood-Pressure method
Monkey	1 ..	1·26	1·29
	2 ..	1·64	1·48
	3 ..	0·66	0·59
	4 ..	1·67	1·67
Dog	1 ..	0·48	0·49
	2 ..	0·50	0·50
	3 ..	0·44	0·54
	4 ..	0·33	0·34

It will be seen from the table that the two sets of results show a good agreement.

KAMALA BHAGVAT.
Department of Pharmacology,
Haffkine Institute,
Bombay,
June 1, 1937.

[1] *J. Physiol.*, 1936, **89**, 5.

Anthracnose of Cucurbits in the Punjab.

SEVERAL cucurbits are grown in India as vegetable crops both in the *kharif* and the *rabi* seasons but anthracnose due to *Colletotrichum lagenarium* (Pass.) Ell. et Hals., [= *Glomerella lagenarium* (Pass.) Stevens] which is supposed to be co-existent with its hosts, has not so far been reported to occur in this country. Uppal, Patel and Kamat[1] mention *Glœosporium* sp. on *dudhi* (*Lagenaria leucantha* Rusby). As it is very difficult to distinguish between the genera *Colletotrichum* and *Glœosporium*, it is possible that the fungus mentioned by Uppal *et al.* is *C. lagenarium*. Aside from this, the writer has not so far come across any other published report regarding the occurrence of this disease in India.

In April 1937, the writer found that severe damage was being done to *kakri* (*Cucumis melo* L. var. *utilitissimus* Roxb.) and *kaddu* (*Lagenaria vulgaris* Seringe) in fields near Ferozepore in the Punjab. Nearly an eighth of the crop had already been destroyed and the disease was spreading rather alarmingly. In newly attacked plants small yellowish to brown spots were manifest on the lamina of the leaves and in advanced cases large brown areas with dead, cracked centres were noticed Many of the leaves, especially the young ones, were crinkled and distorted and had a scorched appearance in the dead plants. Similar elongated lesions were present on the petioles and the stems. Fruits were just beginning to form and, in affected plants, many of them showed sunken, water-soaked cankers which were oval to longish. In advanced cases the plants were outright killed and there was every chance of loss of the entire crop.

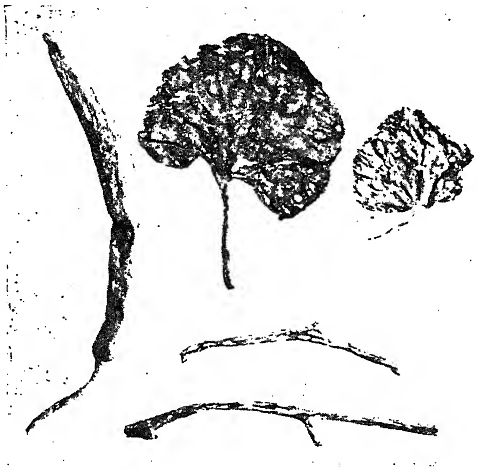


Fig. 1.

Anthracnose of cucurbits showing lesions on leaves and stems, and cankers on young fruit. Note crinkled and distorted leaf.

About five days previous to this, the crop was very promising but the rains in the early part of April seemed to have started "infection centres" and within these few days much loss had already been inflicted. According to the farmer this same disease

had been observed in previous years but it had usually appeared much later, when part of the crop had already been harvested. This year, however, it had appeared very early, even before the fruit had started forming. The crop was watered from a well and the disease generally followed the course of the irrigation channels.

The symptoms of the disease very closely resembled the description of cucurbit anthracnose given by Gardner.[2] Acervuli were abundant but setæ were rather rare. Spores were one-celled, hyaline, oblong to ovate-oblong and slightly pointed at one end with two or three vacuoles. Spores formed on the plants had a range of 12–27 × 4–6 μ with a mean of 16·5 × 5·1 μ, the range given by Gardner being 13–19 × 4–5 μ. The spores of the Indian fungus are therefore slightly longer than those of the American fungus.

The disease has been shown to be seed borne in the U.S. Experiments to determine the host range, seed treatment, sprays, etc., have been undertaken. The photograph shows lesions on the leaves and stems, and cankers on the fruit.

B. B. Mundkur.

Imperial Agricultural Research
Institute, New Delhi,
April 27, 1937.

[1] Uppal, B. N., Patel, M. K., and Kamat, M. N., "The Fungi of Bombay," *Bombay Dept. Agri. Bull.*, 1934, 176.

[2] Gardner, M. W., "Anthracnose of cucurbits," *U.S.D.A. Bull.*, 1918, **727**, 1–68.

Mutations in Gram *Cicer arietinum* L.

In the bulk-plots sown with Pusa gram Types 17 and 25 at Karnal,* two mutations were observed in the year 1934. A brief description of these is given below.

Mutation in Pusa Gram Type 17.—The most striking feature of this mutant is its simple leaves unlike the compound leaves of gram Type 17 (Figs. 1 and 2). The leaf-blades show a few deep incisions which in some leaves reach almost the mid-rib, dividing the lamina into lobes. The lobes are joined at the base. The leaves on the main axis exhibit deeper incisions than those on the branches. The shape of the first leaf on the branches is constant. Here the incisions are few and the apex is round. The

Fig. 1.

Mutant in Type 17 gram.

Fig. 2.

Type 17 gram.

shape of the leaf-blade in other leaves is very variable. The stipules are green leafy structures and are either free from the lamina or jointed to it on one or both sides. In the plants of Type 17, the stipules are free from the leaf-blade. The mutant plants are semi-spreading and more open than those of Type 17. The lower branches have a tendency to grow longer than those arising from upper nodes.

The flowers, pods and seeds do not differ from those of Type 17.

Mutation in Pusa Gram Type 25.—This mutation is equally interesting. The leaf, which again is the part affected, is compound, pinnate and stipulate. The leaf-size is considerably reduced. The leaflets are tiny, and lanceolate to ovate in shape with a serrate margin. The main mid-rib branches into secondary mid-ribs on which are borne the tiny leaflets. In some leaves, the leaflets arise from the tertiary mid-ribs. Towards the tip of the main mid-rib, a few leaflets arise from it and the apex terminates in a solitary leaflet. The leaf stalks are 1·0 to 1·5 mm. in length. The lowermost leaves have longer stalks. The stipules are quite distinct from each other. The branches, the mid-ribs and the leaflets are all hairy. The foliage is dull green. The leaflets on an average are 7·25 × 3·08 mm. in size while those of Type 25 measure 11·1 × 6·5 mm. In habit the mutant plants are bushy and crowded—very different from those of Type 25. The flowers, pods and seeds resemble those of Type 25.

Branches of the mutant and of Type 25 are illustrated in the photograph (Figs. 3 and 4).

* This study was commenced at the Botanical Sub-station, Karnal, financed by the Imperial Council of Agricultural Research, which was transferred to Pusa in 1936. The assistance of the Council is gratefully acknowledged.

Fig. 3.
Type 25 gram.

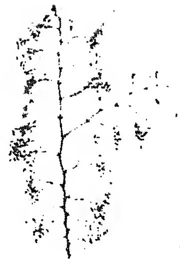


Fig. 4.
Mutant in Type 25 gram.

Further investigations are in progress.

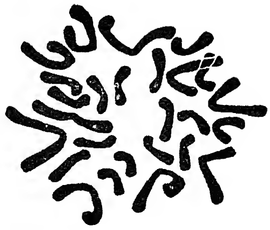
R. B. EKBOTE.

Imperial Agricultural Institute,
New Delhi,
May 19, 1937.

Chromosomes of *Rana tigrina*.

CONSIDERABLE advance has been made during recent years in our knowledge of the Amphibian chromosomes, and several species belonging to the genus *Rana* have been investigated in this direction. But so far as we are aware no report exists up to the date of writing as regards the chromosomes of the well-known Indian species, *Rana tigrina*.* A brief account of our preliminary observations on the chromosomes of this species is presented herewith.

A polar view of the equatorial plate in the metaphase clearly shows 26 chromosomes of different sizes and shapes having V- and J-shape. We have examined several plates showing this stage and in all of them invariably the number of chromosomes is 26 showing the above-mentioned variation in size and shape as shown in the accompanying Fig. 1. All the chromosomes seem to show median or sub-median fibre attachment, since they show constrictions either median or sub-terminal. In this respect, therefore, the Indian species resembles the Japanese forms, *R. nigromaculata* and *R. rugosa* investigated by Iriki[1] and the European form, *R. esculenta* studied by Galgano.[2] However, the Indian frog differs from *R. temporaria*, studied by Makino[3] in the fact that in the latter species there are constantly found two very small grain-like chromosomes, which are absent in the



1

2

Fig. 1. Spermatogonial metaphase showing 26 univalent chromosomes.

Fig. 2. Primary spermatocyte metaphase showing 13 bivalents. Camera lucida drawings, magnification being 4200 ×

chromosomal complex of *R. tigrina*, *R. nigromaculata* and *R. rugosa* and *R. esculenta*

In the primary spermatocytes 13 bivalents are seen at the metaphase (Fig. 2), five or six of which are of large size while the remaining are small. All the chromosomes appear thick and much condensed as is generally the case with the majority of Anurans so far studied.

J. J. ASANA.
R. G. KHARADI.

Gujarat College,
Ahmedabad,
May 26, 1937.

* See the list by Oguma and Makino, *J. Genet.*, 1932, **26**.

[1] Iriki, Sh., *Science Reports of the Tokyo Bunrika Daigaku*, 1932, **B 1**, 61.
[2] Galgano Mario, *Monitore Zoologico Italiano* supp., 1931, **41**, 224.
[3] Makino, S., *The Proceedings of the Imperial Acadamy*, 1932, **8**, 1, 23.

Pearl-like Concretion from a Siluroid Fish.

WHILE investigating the fauna of the Calcutta Corporation Waterworks at Pulta in November 1936, the author had the occasion to collect a large number of dead or dying Siluroid fishes of the species, *Rita rita* (Hamilton) found floating in one of the *pucca* settling tanks which were buried after examination in a pit in the earth with a view to prepare the skeleton. After four months, *i.e.*, in March 1937 while the skeletal remains were being removed from the pit, the author observed a small, bright, salmon-coloured, transparent spherical mass attached to a piece of disintegrated tissue sticking to the skeleton of the dorsal fin. Closer examination showed this to be a pearl-like concretion (Fig. 1) not unlike those from marine fishes in general appearance and structure previously recorded by the author.[1] There were meridional cracks, both superficial and

deep, on the surface of the concretion revealing several concentric layers of apparently chitinous material which were strongly striated in a meridional direction. The

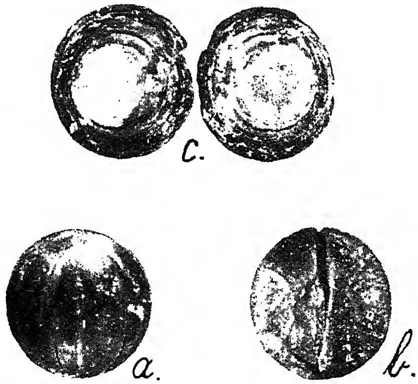


Fig. 1 × 7.

Pearl-like concretion from a Siluroid Fish.

a—Before immersion in water. *b*—After immersion in water for three days. *c*—The inner surfaces of the concretion cut in a slightly excentric section passing through the nuclear part and showing the loose concentric layers composing the concretion.

concretion was 2·8 mm. in diameter, 0·0138 gm. in weight, and had a refractive index of 1·560. The specific gravity was 1·394 when dry and 1·604 after immersion in water for 3 days, showing that the concretion was capable of absorbing a considerable quantity of moisture. After 3 days in water, the concretion showed more longitudinal cracks and splitting of the layers, lost its transparency, and its colour which faded to a dull pale-brown (see Fig. *c*). Although a careful search was made in the pit (containing the skeleton of 18 fishes) for more pearl-like concretions none was found. The formation of such 'pearls' in fish is presumably very rare. The position in which the 'pearl' was found does not imply that there was an organic connection between it and the tissues underlying the dorsal fin, for under the conditions of putrefaction in the pit the 'pearl' may have been displaced from its original location in some other part of the body of the fish, and come to lie on the skeleton of the dorsal fin.

The occurrence of the skeletal remains of a marine Siluroid fish in *Caranx* (*Caranx*) *melampygus* Cuv. Val. from the Andamans (*vide* p. 97 of the reference cited) along with pearl-like concretions, and the present occurrence in freshwater Siluroids of similar 'pearls' seem to suggest that the phenomenon is probably peculiar to the Siluroids, but the present meagreness of knowledge on the subject does not warrant such a conclusion.

The author's thanks are due to his friend, Dr. M. S. Krishnan of the Geological Survey of India, for the determination of the specific gravity and refractive index of the 'pearl'.

H. SRINIVASA RAO.

Zoological Survey of India,
Calcutta,
June 4, 1937.

[1] *Proc. Nat. Inst. Sci. India*, 1936, **2**, 93–100, pl. ii.

Influence of the Phenyl and Carboxyl Groups on the Course of Reaction in Walden Inversion Processes.

CONTRADICTIONS in the empirical generalisations of Frankland[1] and Horton[2] and the inadequacy of the experimental data available to test the rules have already been pointed out.[3] With a view to understanding the influence of the carboxyl and phenyl groups in the course of reaction in Walden inversion processes, substitution reactions with monoethyl-*l*-malate (I), *l*-α-hydroxy-glutaric acid (II), *l*-α-hydroxy-*iso*valeric acid (III), and *l*-α-hydroxy-*iso*caproic acid (IV) have been studied. Substance (I) gave monoethyl-*l*-chlorosuccinate by treatment with thionyl chloride while diethyl-*l*-malate is known to yield diethyl-*d*-chlorosuccinate lending direct evidence to the validity to Horton's rule. (II), (III) and (IV) are found to react with thionyl chloride and subsequently with hydroxylating agents (potassium hydroxide or silver oxide) just in accordance with the requirements of the above rule. The uniform behaviour of a halogenating agent and a hydroxylating agent when employed successively, as observed in the above experiments, also lends support to Horton's generalisation.

The author wishes to express his thanks to Dr. P. C. Guha for his keen interest in the above investigation.

V. ANNA RAO.

Department of Organic Chemistry,
Indian Institute of Science,
Bangalore,
June 21, 1937.

[1] Frankland and Garner, *J.C.S.*, 1914, **105**, 1101.
[2] C. L. Horton, *Chem. News*, 1913, **108**, 37.
[3] Anna Rao and Guha, *J. pr. Chem.*, N.F., 1933, **138**, 167.

REVIEWS.

Television Cyclopaedia. By A. T Witts. (Chapman and Hall, Ltd., London). Pp. 151 with 97 figures. Price 7*sh.* 6*d.* net.

To a person writing a book of this kind, the problem is always one of range and selection, of what to include and where to stop. And in the case of television engineering requiring some knowledge of a variety of subjects, for example, optics, fluorescence phenomena, electronics, high-frequency technology, motion-picture engineering practice, electrical engineering, etc., the question of selection is by no means easy. On the whole, the book is fairly comprehensive with its hundreds of items.

Supported by nearly 100 figures, the author gives brief explanations for each item listed in the book ; these occupy only one line in some cases and over two pages in others. Brevity is not secured at the expense of clarity ; the reader does not get the impression of jerkiness or multilation. The arrangement in alphabetical order is helpful in locating any desired item quickly; and no index is required. On the other hand, it cannot be expected to give a connected account of the subject as a whole.

On pages 133 and 134, it would have been more satisfactory to have written *diffraction* for *defraction* ; at the bottom of page 133, *defraction body* is better written *diffracting medium.*

Any one interested in television engineering, will find this book really useful. The printing and get-up leave little to be desired and the price is not excessive. R.E.

Culture Methods for Invertebrate Animals. J. G. Needham, Chairman, Committee of Preparation. (Comstock Publishing Co., Inc. Ithaca, New York), 1937. Pp. xxxii + 590. Price 4 dollars.

A compendium of the utmost importance to every zoologist including the modest high school teacher whose sole aim is to thrill his young and eager pupils with the magic of the living and moving animals, has been made possible by the co-operation of a large number of American zoologists, and by a grant of the National Research Council. The idea which originated at one of the meetings of the American Association for the Advancement of Science was taken up by an influential Committee under the chairmanship of Prof. J. G. Needham whose call for co-operation and material met with generous and prompt success. The result has been the production of an immensely important book for which, though the Committee modestly claim only the status of a compendium and the beginning of an effort, is nevertheless a very successful and efficient effort.

Perhaps the most valuable contribution is that embodied in the first part of the work where a general account of the methods of collecting and maintaining marine and fresh-water invertebrates is given by the members of the Committee. The importance of this section which includes extremely useful general information is considerably heightened by beautiful illustrative figures of the simple apparatus that one needs to set up in one's laboratory for rearing animals, apparatus which in most cases, one can make for one's self.

The section on the Protozoa is headed by a general account of how cultures of free-living protozoans may be made. Media for chlorophyll bearing animals, for colourless flagellates, ciliates and the Sarcodina are listed. Then follows a series of methods for a variety of protozoans belonging to all orders. A brief account of methods to rear sponges from larvæ as well as from dissociated cells is given, also the raising and care of the common cœlenterates, flatworms and annelids. The section on the Arthropoda is necessarily the longest, that on insects alone extending over 250 pages, the insects of economic importance being treated at great length. Often the methods tried by more than one author are given to enable the reader to benefit by the experience of a variety of specialists in the line. Brief accounts of the methods of rearing many of the common molluscs, echinoderms and ascidians are also given.

In each case, the medium of growth, the food and very often the temperatures at which the cultures give the best results, are given. In many cases, the details of the method of feeding are also noted. Every contribution is supported by a bibliography and sometimes useful cross references to allied species are given. A comprehensive

Index and a list of contributors considerably heighten the value of the work.

B. R. S.

The Spotted Bollworms of Cotton (*Earias fabia* Stoll., and *Earias insulana*, Boisd) in South Gujarat, Bombay Presidency. By B. P. Deshpande and N. T. Nadkarny. (Imperial Council of Agricultural Research, Delhi), 1936. Pp. 208. Price Rs. 6–14 or 9*sh*. 6*d*.

The monograph deals with the results of investigations on the spotted bollworms, financed by the Indian Central Cotton Committee, and carried out at Surat for 8 years from 1923 to 1931. The authors, after mentioning about the occurrence of the bollworms in different parts of the world and in different places in India, give in detail the life-history and habits of the pest after which the types of damage done to the cotton crop are described. The authors also deal with the control methods tried by them such as the removal of attacked shoots, the growing of trap crops, the use of deterrants, attractants and insecticides, parasite liberation and general clean-up measures. In a series of appendices information is given on the spotted bollworms in Khandesh and also on the cotton shoot roller and the pink bollworm.

As a result of their studies the authors state that the pest is active throughout the year and that its life-cycle is completed in 22–35 days. The moths are capable of aying on an average 432 eggs. In South Gujarat, the caterpillars are known to go to the soil for pupation. Both species of *Earias*—*E. fabia* and *E. insulana*—are present, the former predominating. According to the authors, 20–69 per cent. of the shed bolls are found damaged by the worms. Of the several methods tried for the control of the pest they claim that clean-up measures such as the destruction of alternate food plants and uprooting of cotton soon after the *kapas* are harvested with a view to starving the pest during the off-season are the most effective. These are being tried in the Broach District and the results of these trials are awaited with interest.

The authors have given us a good deal of information on the pest. The various plates in the monograph have added to the usefulness of the publication. The results of the investigations are useful not only to those dealing with the cotton crop in South Gujarat but also to others in different parts of India where *Earias* is a pest. The authors are to be congratulated on their publication.

M. C. Cherian.

Journal of the Osmania University. Vol. III. (1935. Issued by the Editorial Board, on behalf of the Osmania University Research Board, Hyderabad—Deccan.)

The academic destiny of the Osmania University is entrusted into the hands of a Research Board consisting of representative heads of different departments embraced by the University. Under the auspices of this distinguished body of professors, the University issues an official Journal portraying the results of research work conducted in its laboratories. Although the University is a comparatively young institution, it has already taken an honourable place among the older academic bodies by its activities, which are at once impressive and praiseworthy. We have received a copy of the third volume of the Journal of the Osmania University, which maintains the high standard of scientific and literary excellence established by its predcessors. This University has the unique distinction of using Urdu as the medium of instruction and examination and the foresight of the Government of H.E.H. The Nizam in courageously adopting this experiment is amply justified by the fruitful results already achieved, and practically with unlimited resources at its disposal, the promise of the future is bright and encouraging.

The English division of the Journal contains 8 articles of literary, historical and scientific interest. Dr. R. Siddiqi in his paper "On a System of Non-Linear Partial Differential Equations of Parabolic Types" discusses the generalisation of the method of dealing with the boundary problems of the first and third kinds for single parabolic equations, and Mr. K. R. Rao and Dr. S. Hussain give a historical sketch of the electrodeposition of chromium from potassium dichromate Baths. The article on the Biology, Ecology and Bionomics of the Fauna of Hyderabad State by Mr. M. Rahimulla and Dr. B. K. Das, deals with fresh-water fish and is full of interest. Other equally interesting papers deal with "Meteoric Showers" by Mr. Mohd. A. R. Khan, the influence of nutrition on sexual expression in maize by Messrs. Abdul Bari and M. Abdus

Salam, "The Algal Flora of the River Moosi" by Mr. Ghousuddin and Prof. M. Sayeeduddin, "Indian Thought in English Literature" by Mr. E. E. Speight and "Nadir Shah's Invasion" by Dr. Yusuf Hussain.

Indian Journal of Venereal Diseases. (Quarterly: Editing and Publishing Offices, 94, 97, Girgaum Road, Bombay. Annual Subscription: Indian, Rs. 5, Foreign, 10*sh.*)

This quarterly Journal edited by Dr. U. B. Narayan Rao, supported by an international Board of Editorial Collaborators, is issued from Bombay. Undoubtedly a wide diffusion of knowledge of the venereal diseases whose horrors are as lothesome as their spread is dangerously insidious, must be encouraged in order that the unfortunate victims may obtain timely relief from proper medical treatment. Like tuberculosis, syphilis and gonorrhœa are handed down from antiquity, and their ravages are successfully fought by modern scientific discoveries, but their existence in any community must at all times be a foul blot on the people's moral behaviour. This Journal, the only one of its kind in the Indian Empire, has a message which extends beyond the medical profession, and it should be made increasingly manifest to the general public. We have received the first three volumes of this important Journal, which contain information bearing on the many gruesome aspects of the diseases dealt with by experts, which, however unpleasant, should be widely read. Other sections which are discussed in the Journal are Physiology, Bacteriology and Serology, Radiology and Electrology, Endicrinology, Gastro-enterology, Pneumo-cardiology, Urology, Gynecology, Dermatology, Ophthalmology, Oto-Rhinolarynagology, Odontology, Neurology, Surgery Pediatrics, Eugenics and Birth-control. These subjects give an idea of the range of medical and public interests caused by the Journal, whose career is bound to be bright and successful. The annual subscription is Rs. 5 and the publishing offices are situated in 94–97, Girgaum Road, Bombay.

Application a la chimie des Theories Modernes Sur la structure des molecules. Les Donnees Spectrales. By G. Emschwiller. (Actualites Scientifiques et Industrielles, No. 366.) (Hermann & Cie. Paris). 1936. Pp. 41. Price 12*fr.*

This is the substance of a companion lecture to that of M. Allard (Actualite Series, No. 365). The author starts with our present conceptions of structure of atoms and atomic spectra, and passes by easy stages through the various types of molecular spectra and their interpretation. Raman spectra, molecular vibration frequencies, the excited states of molecules, the phenomenon of predissociation, etc.

In publishing this lecture in book form, the author would have increased its utility, if he had incorporated some important references to original literature or other classical books, so that such of the readers who want to pursue the subject further, could do so easily.

CENTENARIES

S. R. Ranganathan, M.A., L.T., F.L.A.
(*University Librarian, Madras*)

Bezold, Johann Friedrich Wilhelm von (1837-1907)

BEZOLD, the German meteorologist, was born at Munich on June 21, 1837. He was admitted to the degree of Ph.D. at Gottingen in 1860. He was Extraordinary Professor in the University of Munich in 1866 and Ordinary Professor at the Polytechnic of Munich in 1868.

Meteorological Career

His meteorological career began in 1878, when he undertook the organisation of the Bavarian meteorological service. He remained as the Director of the Central Meteorological Station till 1885, when he went to Berlin as Professor of Meteorology in the University. He organised the Meteorological Institute of Berlin and became its first Director. In this capacity he was for a long period in charge of the climatology, rainfall and magnetic observations of Prussia and also of the aeronautical section at Tegel.

His Writings

He was the author of nearly 75 papers. While most of those related to meteorology and terrestrial magnetism, a few were on

colour vision, the retina and the dust figures of electrical discharge. His classical papers were on the thermodynamics of the atmosphere, and were contributed to the Berlin Academy. In a meeting of the Association of Academies held in London in 1904, he elaborated a proposal for testing Gauss's theory of terrestrial magnetism by measurements along a complete circle of latitude. His collected papers were issued in one volume in 1906.

He died at Berlin on February 17, 1907.

Pearce, Richard (1837-1927)

RICHARD PEARCE, the Anglo-American metallurgist and minerologist, was born near Camborne in Cornwall, England, on June 29, 1837. His father was one of the superintendents of the premier mine of Cornwall. After being at the local elementary school till 14, he went to work in the tin-dressing plant of the mine in which his father was employed. In 1855, his ability found recognition and secured for him the post of Assistant Chemist at the Truro Mining School. Three years later, when the School was closed down, he again joined his father. After a short interval he entered the Royal School of Mines in London and later in 1865 went to Freiburg, Saxony, where he learned silver processes, particularly those of Ziervogel and Augustin.

His Career

On his return from Germany, he built a copper smelting plant at Swansea. But it did not prove a success. In 1872, he sailed for Colorado and took charge of a smelter. He threw himself heart and soul into the work and devised and conducted effective processes, by which he separated no less than 32 tons of gold in his stay of 30 years at Colorado. His process which was a trade secret till 1908, was described by his son that year in V. 39 of the *Transactions* of the American Institute of Mining and Metallurgical Engineers.

His Writings

He wrote more than 30 papers, most of which appeared in the *Transactions* of the Colorado Geological Society, or in the *Proceedings* of the Colorado Scientific Society. His first paper, entitled *Note on chrome iron in the Serpentine of the Lizard*, appeared in V. 9 of the *Transactions* in 1878. These papers were mostly on mineralogy and a few were on geology. The paper, *Note on what appears to be a new mineral from the Gagnon mine, Bute, Montana*, which appeared in V. 2 of the *Proceedings*, was later confirmed by others as a note on a really new mineral.

Pearceite and Pearce Furnace.—This new mineral is a black monoclinic crystal of density 6·15 and of the composition $(AgCu)_{16}As_2S_{11}$. His name has been immortalised in the name of the mineral, which has been fixed as *pearceite*. Another invention of his which bears his name is the Pearce turret roasting furnace, which is said to be the first use of a rotating mechanism to rabble ore during roasting.

His Honours

In 1902, he retired from service and returned to Cornwall. He was doing some professional work till 1919, when he left for London. There he remained near to the museum and the schools of science, both of which continued to command his lively interest at that ripe old age. A Ph.D. degree from Columbia in 1890, a gold medal from the Royal Institution of Cornwall in 1909, and another gold medal from the Institution of Mining and Metallurgy in 1925 were the honours that came to him unsought, "in recognition of the services which he had so long rendered to the advancement of metallurgical science and practice".

He died on May 18, 1927, within a few weeks of his ninetieth birthday.

Snelus, George James (1837–1906)

G. J. SNELUS, the British metallurgist, was born on June 25, 1837, in Camden Town, London. His father, who was a master builder, died when George was seven. He was first trained for the teaching profession. While a teacher near Manchester, he attended lectures on science at the Owens College, Manchester, where he came under the influence of Sir Henry Roscoe. This stimulated in him a great desire for a scientific career. In 1864 he obtained a Royal Albert Scholarship and joined the Royal School of Mines. At the conclusion of his course, he obtained an Associateship in Mining and Metallurgy and the De la Beche medal for mining.

His Career

After being a chemist at the Dowlais Works for about five years, he got, in 1871,

a commission from the Iron and Steel Institute to visit the United States and report on the chemistry of the Danks rotary puddling furnace. His report, which was published in V. 1 of the *Journal* of the Institute, proved of the utmost value. On his return from this commission, in 1872, he was appointed Works Manager of West Cumberland Iron and Steel Co., Workington, of which he later became General Manager and remained as such till 1900.

His Contributions

His chief contribution to metallurgy was in the invention of a process for completely eliminating phosphorus from molten pig iron by oxidation. He got this idea during his investigation in the United States. Having found by experiment that lime could be burned at a high temperature so as to be impervious to water, he conceived the idea of lining the Bessemer converter with lime so over-burnt and thus eliminating phosphorus during the Bessemer process. He succeeded in almost entirely eliminating phosphorus from 3 to 4 ton charges of molten phosphoric pig iron and took a patent. But the process did not become a commercial success till 1879, when Sidney Thomas and Percy Gilchrist perfected it.

Another conspicuous contribution of Snelus to metallurgical chemistry was his proof of the practical value of the molybdate method for the determination of phosphorus in steel, a process which is now universally employed.

He wrote about twelve papers, all of which were published in the *Proceedings* of the Iron and Steel Institute.

His Honours

He was a Foundation Member of the Iron and Steel Institute and its Vice-President from 1889 to the time of his death. He was awarded the Bessemer Medal of the Institute jointly with Thomas in 1883. He was also awarded gold medals for his inventions at the "Inventions Exhibition" in 1885, and at the "Paris Exhibition" in 1878 and a silver medal at the "Paris Exhibition" of 1900. He was made a Fellow of the Royal Society in 1887. He was also an enthusiastic member of the volunteer force from 1859 till 1891, when he received several military honours.

He died on June 18, 1906, aged sixty-nine.

ASTRONOMICAL NOTES.

1. **Planets during July 1937.**—Venus will continue to be a morning star throughout the month and on July 16, it will closely approach Aldebaran, the planet being 2½° North of the Star. Mars will resume its eastward motion and although getting fainter, will be a conspicuous object in the evening sky, crossing the meridian about an hour after sunset. On July 17, the Moon occults Mars; the actual occultation will not be visible from any place in India, but the close approach at the time of the setting of the Moon will be worth observing. Jupiter will be in opposition to the Sun on July 15, while Saturn rising about an hour after midnight will be nearly overhead early in the morning, its stellar magnitude on July 16 will be 1·0. Uranus will be about midway in the sky between Saturn and Venus and can be picked up with a binocular.

2. **Comets.**—Whipple's comet (1937 *b*) is still bright and will pass perihelion on June 20. It is a fairly easy object of about the ninth magnitude in the constellation Boötes. It is slowly moving in a south-easterly direction and can be seen readily with a small telescope. Comet Grigg-Skjellerup was detected by Mr. L. E. Cunningham of the Harvard Observatory on April 30. At the time of observation, it was a faint object magnitude 13 and its approximate position was R.A. 6 *h.* 59 *m.*, and Decl. 7°53′ N. The comet passed perihelion on May 23. It is a periodic comet with a period of 5·0216 years and this is the fifth observed apparition since its discovery in 1922.

3. **New Stars.**—Nova Herculis (1934) is steady at about magnitude 8·5 with only some small fluctuations in brightness, ranging about half a magnitude. Nova Lacertæ (1936) is slowly declining, its magnitude on June 5 was 10·70. Of the two novæ in Aquilæ discovered by Tamm last year, the first does not show much variation in brightness, but the second nova is definitely fading having declined to the 12th magnitude on June 8.

Some Aspects of the Chemistry of Swamp Soil.

By Prof. V. Subrahmanyan, D.Sc., F.I.C.,
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THE study of swamp soil is of considerable practical importance and has a direct bearing on both agriculture and public health. The related problems are so numerous and so varied in character that they offer scope for all branches of science. Their solution will unravel the mystery which still surrounds the nutrition of the rice plant and will throw fresh light on the nature of life and life processes in the submerged soil.

It will be beyond the scope of a brief review to deal with all the related problems, so the present article is confined to certain chemical aspects having a bearing on the nutrition of the rice plant.

The agricultural operations connected with the cultivation of rice are generally well known and do not require any repetition. It may be pointed out, however, that some of them would require revision, or at any rate, better control in the light of recent scientific findings.

It is generally well known that in certain regions—especially in river deltas—the yield of rice is maintained at a fairly high level though practically no manure is applied. Even in the same locality, certain fields are known to be consistently more fertile than others though they may lie very close to each other. This difference is largely traceable to the extent of deposition of silt, some areas receiving more than others.

The biochemistry of river silt has not yet been adequately studied. The quantity of silt carried by each river, the amount deposited in different seasons, its distribution over the irrigated field. and its contribution to the succeeding crop—all these are important problems which are still awaiting solution. There is no doubt that some of the silts are quite rich and contain over 3,000 parts per million of nitrogen. There is also evidence to show that river silt facilitates oxidation changes.[1] Further studies in this direction may yield highly fruitful results.

In recent years, evidence has been adduced to show that one of the probable causes for the preservation of the fertility of the swamp soil is through fixation of atmospheric nitrogen. The fixation may be in symbiosis with the plant[2] or through the agency of free living organisms.[3] These researches are worthy of extension, with adequate crop experiments to check the various findings. The influence of various external factors—especially deposition of silt—on the nitrogen content of soil should also be determined.

There is evidence to show that, under submerged conditions, the mechanical composition of the soil is altered. The finer fractions tend to increase at the expense of the coarser ones. This has been traced[4] to the decomposition of organic matter (through biological agencies) resulting in the dissolution of minerals (chiefly iron and aluminium) present in the coarser fractions and their subsequent re-precipitation in the finer form. It would be of interest to follow the bearing of this on the increased heaviness observed in some of the areas which have been continuously under rice cultivation.

Some earlier workers[5] have reported that even mere increase in the moisture content of the soil leads to loss of nitrates and even total nitrogen. This is not supported, however, by later researches,[6] which show that when an uncultivated soil or one which has been fallowed for some time is water-logged, there is very little change in total nitrogen. The nitrate content (which is generally small) is further lowered and there is slight increase in nitrites. The most significant change is the production of ammonia, a large part of which is ordinarily retained in the soil sediment : very little passes into the supernatant, so that loss by leaching is comparatively small. If the water level goes down and the soil is exposed to dry, then a considerable part of the ammonia in the soil system is lost by volatilisation.

The mechanism of production of ammonia in the submerged soil has not yet been fully[7] understood. Evidence has been adduced to show that it is derived through degradation of plant residues and disintegration of microbial cells. Although the living organisms do not increase, the enzymes associated with them (especially the deaminase) bring about the desired change. In a manured soil, however, the changes are more complicated, as will be seen in a later section.

In the absence of freshly decomposing organic matter, the biological oxygen demand of the submerged soil is comparatively small. There is slow but steady movement of dissolved oxygen from the surface water into the soil below.[8] The conditions are considerably altered in presence of unrotted organic matter. The dissolved oxygen is very rapidly used up and the medium gets saturated with carbon dioxide and other gases.[9] The conditions become definitely anaerobic, and it is not until the completion of the fermentation that the oxygen of the atmosphere enters the soil system. On prolonged exposure, the dissolved gases pass out into space and aerobic conditions are then restored. In field practice, this process takes 3–5 weeks (depending on the nature of the soil and the amount of organic matter applied) for completion. The land is then fit for the crop.

The production of gases during decomposition of organic matter in the swamp soil has been the subject of a number of enquiries. The most outstanding contributions in the line are those of Harrison and Aiyer.[10] Working with the green-manured soils of South India, those authors showed that the chief gases produced during the fermentation are methane, hydrogen, carbon dioxide and nitrogen. These, on rising to the surface, encounter some active, aerobic bacteria, which oxidise methane to carbon dioxide and hydrogen to water. Carbon dioxide is taken up by the green algæ present at the surface of the soil and oxygen is released.

In this manner, the undesirable gases are removed and only oxygen and nitrogen are evolved from the soil system. Evidence has also been adduced to show that plant roots assist in facilitating oxidation changes in the soil.

Shortly after ploughing in the organic manure (generally a green manure), gas production begins. There is steady evolution over a number of days. The soil is then unfit for the crop : in fact, any that may be planted will be readily killed out. After the initial fermentation has largely subsided, then the algæ become prominent. The oxidation changes reported by Harrison and Aiyer are also noticeable during this period.

The manner in which the rice plant obtains its air supply has interested a number of workers, but no conclusive evidence has so far been obtained. Only the dissolved oxygen of the surface water is available to the root system and it is generally believed that the roots are highly adaptable and can function in the same manner as those of aquatic plants. In this connection, it may be mentioned that the plant thrives well only if a gentle flow of water is maintained. Prolonged stagnation of the surface water affects the growth and depresses the yield. Too great a depth of water is not beneficial to the crop, though certain varieties are able to stand it better than others.

Together with the gases, varying quantities of organic acids are produced in the soil system. The acids are chiefly lactic, acetic, propionic and butyric.[11] The first acid to be formed, and the one which is often produced in the largest amounts, is lactic acid. After a week or ten days, the quantity of lactic acid diminishes and is followed by increase in the other three acids. It may be said, in general, that if air supply is favourable, there is increased production of acetic acid : if unfavourable, greater quantity of butyric acid is produced. The chemical and biological mechanism of the production of acids, as also their bearing on plant growth, are still obscure.

Several workers[12] have drawn attention to the adverse effect of applying nitrates, especially during the puddling period, to the swamp soil. This is largely due to the formation of nitrites in the presence of fermentable organic matter. It is stated that nitrites are highly toxic if present in more than minute quantities. In addition to this, a considerable part of the soluble nitrogen will be immobilised and thus rendered non-available (at any rate for the time being) to the crop.[13]

It has been suggested that, in presence of undecomposed organic matter, the added nitrate may undergo denitrification in the swamp soil. Nitrogen in elementary form may be lost either through spontaneous decomposition (photochemical or otherwise) or through interaction of nitrites with the amino-bodies that may be present in the soil systems. The extents to which the different types of changes contribute to loss of nitrogen have not yet been assessed. In this connection, attention may be drawn to the work of Fowler and Kotwal[14] who adduced evidence to show that loss of nitrogen through purely chemical changes is negligible.

Most workers[15] are agreed that nitrates should not be applied to the swamp soil in the early stages. At a later period, however, and especially just prior to flowering, the crop responds well to nitrates and increased yields have been reported.

Nitrogen transformations attendant on the decomposition of different organic substances has been studied by a few workers.[16] It has been found that substances with narrow C-N ratios are ordinarily decomposed, rapidly yielding considerable quantities of ammonia. Only small quantities of nitrates are formed. There is also significant loss of total nitrogen. This loss is mostly traceable to volatilisation of ammonia. Similar changes, though less pronounced, occur also under dry soil conditions.[17]

Volatilisation of ammonia and attendant loss of nitrogen can be largely prevented by addition of substances with wide C-N ratios. Thus, addition of powdered lantana or glucose will check the loss of nitrogen from soils receiving rich dressings of urea or dried blood.

When substances with wide C-N ratios are applied, there is very little ammonification and practically no loss of total nitrogen. On the other hand, there is steady loss of carbon until a C-N ratio of about 15–1 is attained. After that stage, both carbon and nitrogen are lost, though comparatively slowly.

Volatilisation of ammonia is not probably the only means by which nitrogen may be lost from the soil system. There are probably number of other ways which have not so far been adequately understood. A great deal of further work is needed before any conclusive opinion can be expressed on the subject. The problem is one of considerable practical importance and it is hoped that, beforelong, it will be possible to organise a co-operative scheme of research (preferably under the auspices of the Imperial Council of Agricultural Research) which will not only throw fresh light on the mechanism of nitrogen loss, but will also lead to the development of new and improved methods of conserving soil nitrogen.

Except for the production of certain gaseous and water-soluble products, the transformation of organic carbon in the swamp soil have not so far been adequately studied. Thus, it will be of interest to determine the nature of the residual organic matter, the quantity left at each stage and the transformations subsequently undergone by it. Some information is available regarding water-soluble substances like cane molasses or urea which, if applied in moderate quantities, are completely decomposed and leave practically no solid residue.[18] The changes undergone by bulky organic manures, which are attacked more slowly, are awaiting elucidation.

In spite of their very great practical importance, mineral transformations in the swamp soil have not so far attracted much attention. It is only in recent years that some work has been undertaken and the available results may be summarised as follows :—There is increased availability of calcium and potassium. This is no doubt greatly facilitated by the decomposition of organic matter and consequent production of organic acids. Availability of phosphorus is also increased. Indeed, Sivan[19] has shown that

ploughing in with green manure is one of the cheapest methods of increasing the availability of rock phosphates. Increasing quantities of certain metallic ions (especially ferrous iron) are also brought into solution.[20] The extent of dissolution of iron is influenced by a number of factors such as the nature of the soil, the chemical composition of the organic matter, reaction of medium, temperature, degree of submergence and such like.[21] In soils which are alkaline or contain useful quantities of lime or other buffering constituents, the iron is precipitated almost immediately after it is brought into solution. In other types of soils (especially acid ones), the iron in solution continues to persist for several weeks. The dissolved iron is present, not as bicarbonate as suggested by some earlier workers[22] but mostly as salts of organic acids. After the subsidence of the initial fermentation and on exposure to air, it undergoes hydrolysis and tends to get oxidised, with the result that iron is deposited in finely divided form as ferric hydroxide. It is this which constitutes the red-brown, fluffy layer often found at the surface of the swamp soil. In addition to this, iron is also precipitated as the carbonate, sulphide or the phosphate. The last reaction involves the removal of a part of the phosphate in solution. The precipitated phosphate is finely divided and is available, at any rate, to the immediate crop.[23]

If present in more than traces, ferrous iron in solution is toxic to plant growth. It would follow, therefore, that the soils in which the iron continues to remain in solution for long periods require some rest before the crop can be planted. On the other hand, the soils in which the iron is rapidly precipitated require very little rest and are suitable for early planting. The right stage for planting is now determined empirically, but it should be possible to develop some simple chemical methods of determining it.

The rôle of the precipitated or oxidised iron has not yet been fully worked out. *Being finely* divided and intimately mixed with the residual organic matter, it should be highly potent in bringing about oxidation changes and thus increasing the availability of plant food. Some useful evidence in this direction has already been obtained.[24]

The transformations of iron may be represented as follows :—

$$\underset{\text{(insoluble)}}{Fe^{\cdots}} \xrightarrow[\text{(In presence of fermentable orgnaic matter)}]{\text{Reduction}} \underset{\text{(soluble)}}{Fe^{\cdot\cdot}} \quad .. \quad (1)$$

$$\underset{\text{(in solution)}}{Fe^{\cdot\cdot}} + \underset{\text{(Product of fermentation or already present in soil)}}{\begin{matrix} H_2S \\ X_2CO_3 \\ X_3PO_4 \end{matrix}} \longrightarrow \underset{\text{(precipitate)}}{\begin{matrix} FeS \\ FeCO_3 \\ Fe_3(PO_4)_2 \end{matrix}} \quad (2)$$

$$\underset{\text{(exposure to air)}}{2\,Fe^{\cdot\cdot} + 3O + H_2O} \longrightarrow \underset{\text{(fluffy precipitate)}}{Fe_2O_3 \times H_2O} \quad (3)$$

$$2\,Fe_2O_3 + \underset{\text{(residual organic matter)}}{C} \longrightarrow 4\,FeO + CO_2 \quad .. \quad (4)$$

$$2\,FeO + \underset{\text{(re-exposure to air)}}{O} \longrightarrow Fe_2O_3 \quad .. \quad .. \quad (5)$$

Small quantities of aluminium are also brought into solution. It is very difficult to estimate this quantity because even with the least agitation, the dissolved aluminium passes again into insoluble condition. It is then present as an exchangeable base and can be extracted in the usual way.[25] The mechanism of dissolution and the subsequent transformations of aluminium are still awaiting elucidation.

Decomposition of organic matter also facilitates increased dissolution of manganese. At the outset, the manganese of the soil is mostly present as the dioxide, some soils containing more than others. In the reducing atmosphere of the puddled soil and in presence of the acids, the dioxide is reduced and brought into solution in the manganous condition. As in the case of iron, the quantities actually present in solution are determined by a number of factors, the most important of which is the reaction. When the fermentation subsides, manganese in solution is first precipitated and then oxidised to a hydrated oxide. The latter is highly reactive and facilitates subsequent oxidation changes in the soil.[26]

The transformations of manganese and their bearing on the nutrition of the rice plant have not yet been fully worked out. Further work in this direction will lead to highly fruitful results.

Another interesting change, attendant on swamping, is the increased availability of silicon. Application of organic manures (especially green manure) further improves the availability. Since the rice plant (especially the straw and the husk) is exceptionally rich in silicon, the increased availability of this element may, at any rate, partly account for the beneficial effect of swamping.[27]

The mechanism of dissolution of silicon has not, so far, been fully understood. It may be mentioned, however, that soluble silicates (which behave in the same manner as colloidal silica) increase the availability of phosphorus. This aspect of the problem has been studied by a number of workers, but the more recent work of Sreenivasan[28] would suggest that silicon acts by combining preferentially with the soil complex and thus releasing phosphorus for the plant. Fermentation of organic matter releases phosphorus and thus produces an effect which is somewhat similar to that of light dressings of alkali silicate.[29]

One of the most striking features about the cultivation of rice is the enormous demand for water. All the superior varieties of rice and, even many of the coarser ones, flourish best only under the conditions of the swamp soil. The crop, by itself, takes very little water—at any rate, no more than most other dry cultivated crops do.[30] It is, nevertheless, a common experience that if the water supply is reduced or the crop raised under conditions of dry cultivation, growth is adversely affected and yield considerably lowered. The available evidence would suggest that swamp soil conditions provide certain constituents which are not, ordinarily, readily available in the dry soil. One of these is silicon, but there are probably great many others which are essential to the rice plant and

are released only under the conditions of the swamp soil. If the nature of these substances can be determined, it may be possible to provide them in comparatively stable forms even under dry soil conditions and thus improve the yield of rice. Intense research in this direction will lead to findings of very great practical value.

[1] Fowler and Deo, *J. Ind. Inst. Sci.*, 1921, **4**, 149.

[2] Sen, *Agri. J. India*, 1929, **24**, 229.

[3] De, *Ind. J. Agric. Sci.*, 1936, **6**, 1237.

[4] Sreenivasan and Subrahmanyan, *Proc. Ind. Acad. Sci.*, 1934, **1**, 123.

[5] Oelsner, *Centrabl. Fur. Bakt.*, 1917–18, **II, 48**, 210. k

[6] Subrahmanyan, *J. Agric. Sci.*, 1927, **17**, 429.

[7] Subrahmanyan, *ibid.*, 449.

[8] Subrahmanyan, 1927, *loc. cit.*

[9] Subrahmanyan, *J. Agric. Sci.*, 1929, **19**, 627.

[10] Harrison and Aiyer, *Mem. Dept. Agric. India*, 1913, **3**, 65; 1914, **4**, 1; 1916, **4**, 135; 1916, **5**, **1**; Harrison, *ibid.*, 1920, **5**, 181; Aiyer, *ibid.*, 1920, **5**, 173.

[11] Subrahmanyan, 1929, *loc. cit.*; Bhaskaran, Narasimhamurthy, Subrahmanyan and Sundara Iyengar, *Proc. Ind. Acad. Sci.*, 1934, **1**, 155.

[12] Nagaoka, *Bull. Tokyo Coll. Agric.*, 1904–05, **6**, 285; Daikuhara and Imasaki, *Bull. Imp. Agric. Sta., Japan*, 1907, **1**(2), 7; Kelly, *Hawaii Agric. Expt. Sta. Bull.*, 1911, No. 24.

[13] Subrahmanyan, 1929, *loc. cit.*

[14] *J. Ind. Inst. Sci.*, 1924, **1**, 29.

[15] Kellner, *Landw. Versuchstat*, 1884, **30**; Nagaoka, *Bull. Coll. Agric. Tokyo*, 1904, **5**; Kelly, *Hawaii Agric. Expt. Sta. Bull.*, 1911, No. 24; 1914, No. 31; Dastur and Malkani, *Ind. J. Agric. Sci.*, 1933, **3**, 157.

[16] Harrison, *J. Bd. Agric. Brit. Guiana*, 1912, **61**, **71**; Itano and Arakawa, *Ber. Ohara Inst.*, 1927, **3**, 331; Osugi, Yoshie and Komatsubara, *Mem. Coll. Agric. Kyoto*, 1931, **12**, 1; Sreenivasan and Subrahmanyan, *J. Agric. Sci.*, 1935, **25**, 6.

[17] Sreenivasan and Subrahmanyan, 1935, *loc. cit.*

[18] Sreenivasan and Subrahmanyan, 1935, *loc. cit.*; Narasimhamurthy and Subrahmanyan, *Proc. Ind. Acad. Sci.*, 1935, **1**, 823.

[19] *Mem. Dept. Agric. Ind. Chem. Ser.*, 1925, **7**, 145.

[20] Bhaskaran *et al.*, *loc. cit.*

[21] Sundara Iyengar and Subrahmanyan, *Proc. Ind. Acad. Sci.*, 1935, **1**, 868.

[22] Robinson, *Soil Sci.*, 1930, **30**, 197.

[23] Sreenivasan and Sadasivan, unpublished data.

[24] Harihara Iyer, Rajagopalan and Subrahmanyan, *Proc. Ind. Acad. Sci.*, 1934, **1**, 106; *ibid.*, 1935, **2**, 108.

[25] Govindarajan, unpublished data.

[26] Harihara Iyer, Rajagopalan and Subrahmanyan, *loc. cit.*; Rajagopalan, unpublished data.

[27] Nanji and Shaw, *J. Soc. Chem. Ind.*, 1925, **44**, 1 T; Sreenivasan, *Curr. Sci.*, 1934, **3**, 193.

[28] *Proc. Ind. Acad. Sci.*, 1935, **1B**, 607; **2B**, 201; 1936, **3B**, 283, 302.

[29] Sreenivasan, *Proc. Ind. Acad. Sci.*, 1936, **3B**, 258.

[30] Briggs and Shantz, *J. Agric. Res.*, 1914, **3**, **1**; Leather, *Mem. Dept. Agric. Ind. Chem. Ser.*, 1911, **1**, 10; B. N. Singh, R. B. Singh and K. Singh, *Proc. Ind. Acad. Sci.*, 1935, **1**, 471.

RESEARCH ITEMS.

Boundary Problem in a Non-Linear Partial Differential Equation of the Fourth Order.—Considering the non-linear partial differential equation $\frac{\partial^4 u}{\partial x^4} + \frac{\partial^2 u}{\partial t^2} = p(x, t)u^3$ in the domain $0 \leqslant x \leqslant \pi$, $0 \leqslant t \leqslant T$, the problem is to find its regular solution $u(x, t)$ satisfying the conditions

$$u(0, t) = u(\pi, t) = 0 \text{ in } 0 \leqslant t \leqslant T,$$

$$u(x, 0) = f_1(x),\ \frac{\partial u}{\partial t}(x, 0) = f_2(x) \text{ in } 0 \leqslant x \leqslant \pi.$$

This has been considered by M. R. Siddiqui (*Ind. Physico-Math. J.*, 1937, 8) and it is found that for a restricted T, one and only one solution exists which can be expressed as a Fourier series $u(x, t) = \sum_n v_n(t) \sin nx$, wherein the coefficients $v_n(t)$ are determined with the help of an infinite system of non-linear integral equations, which is solved by the method of successive approximations.

Amphoteric ion.—A review of considerable interest has recently been published (P. Rumph, 'La Theorde de L'ion Amphotere,' *Actualites Scientifiques et Industrielles*, 1936, No. 374). The review covering just 50 pages is divided into three chapters: (1) the existence of amphoteric ions, (ii) the dielectric constants of aqueous solutions containing amphoteric ions, (iii) calculation of the different dissociation constants and the relationship between the activities of the amphoteric ions and those of the uncharged molecules.

In a brief conclusion, the author draws attention to the usefulness of this concept of amphoteric ions in branches of chemistry other than a pure study of biological substances, such as, in the theory of colouring matters, the constitution of complex compounds of inorganic salts, etc.

Histology of the Skin of *Protopterus*.—The African lung-fish, *Protopterus annectens*, is known

for its powers of æstivation during the dry months of the year, when all physiological activities of the animal are in abeyance. G. M. Smith and C. W. Coates (*Quart. Journ. Micros. Sci.*, March 1937, **79**, Pt. III, No. 315) have examined the structure of the skin of the animal during normal life and during æstivation (which they have been able to induce in the laboratory). The difference between the two skins rests mainly in the structure of the mucous glands which are very conspicuous and large in the normal skin while they are shrunken and small in the skin of the æstivating animal. Certain minor changes also occur in the epithelial cells of the skin during æstivation.

Germ-Cell Origin in the Amphibia.—Diversity of opinion, not solely due to differences in interpretation, exists regarding the origin of germ-cells in the adult Amphibia. Whether germ cells that make their appearance periodically during the lifetime of the animal are the derivatives of the original and primordial germ-cells of the embryo or whether they are formed afresh every season, at least in part, of somatic derivatives is the problem. The evidence presented is conflicting. J. W. Burger (*Journ. Morph.*, March 1937, **60**, No. 2) working on *Plethodon cinereus* finds the germ-cell line in this animal continuous and that primordial germ-cells alone give rise to the germ-cells of the adult by repeated divisions, themselves remaining unchanged throughout the lifetime of the animal. No somatic cell of any kind is seen to give rise to germ-cells, either by a direct transformation or by division. Both cytological as well as statistical evidence is put forward for this theory in the paper. The findings of Seshachar (*Zeitsch. Zell.*, April 1937, **Bd. 26**, H. 2) are exactly opposite. In the Cæcilian *Ichthyophis glutinosus*, he finds that practically the only source of the germ-cells in the adult male is the lining of the duct system whose representative vessels ramify throughout the testis and whose cells are constantly seen transforming into spermatogonia. Residual spermatogonia derived from the primordial germ-cells of the embryo and persisting throughout the life of the animal giving rise to functional germ cells, themselves remaining unchanged, are absent in *Ichthyophis*. While it is possible that both kinds of conditions are found in the Amphibia, it is more than likely that the organization of the testis and the pattern of spermatogenesis determine the particular condition found in the animal.

Theileriasis of Cattle in India.—From a study of a strain of Theileria in artificially infected hill bulls Sen and Srinivasan (*Ind. J. Vet. Sci. and Animal Husb.*, 1937, **7**, 15) have concluded that the incubation period lasts for 16 days in artificial infection but the duration of the disease is only 5·5 days in fatal cases and 4 to 17 days in recovering cases. The disease is characterised by high fever, loss of appetite, enlargement of prescapular and precrural glands and yellow and petichæted condition of the visible mucous membranes. Blood examination at the first rise of temperature shows often rare theileria and Koch's bodies or both. The parasites multiply in the course of the disease and attack 50 to 100% of the red blood cells though Koch's bodies may be few or many. Usually the parasites are seen as round forms, "rods" being rare. The mortality is over 75 %.

Twenty different drugs were tried for remedial effects but the results were neither definite nor satisfactory.

The next article which the authors have promised, dealing with immunisation and treatment with Anti-Serum, will be eagerly looked forward to.

S. D. A.

Pneumonia in Foals due to *Corynebacterium equi*.—A particular form of pneumonia is known to occur with some frequency in certain breeding studs in the Punjab, and the etiology of this condition, which was thought to be identical with that described by Magnusson in Sweden, has been under investigation for some time.

The infection is generally confined to foals about one to two months old, and occasionally symptoms of joint-ill may be seen in addition to those of pneumonia. The mortality is high. Post-mortem examination reveals large abscess cavities in the lungs and the mediastinal glands.

Corynebacterium equi, the causal agent, can be recovered in nearly every case in pure culture from the abscesses in the lungs and mediastinal glands, as well as from the fæces, sometimes from the heart-blood and, rarely, from the joint fluid of naturally as well artificially infected cases. The cultural and biochemical characters of this organism have been newly described (Rajagopalan, *Ind. J. Vet. Sci. and Animal Husb.*, 1937, **7**, 38).

It has been possible to reproduce the typical symptoms of the disease by an intra-nasal douche of a saline suspension of the organism. Age, as in natural incidence, appears to be the chief factor in the artificial reproduction of the disease.

SCIENCE NOTES.

Medical Research in India.—The Scientific Advisory Board of the Indian Research Fund Association has recently published a report in which the results of investigation into the etiology of epidemic dropsy, the causes of maternal mortality, the nutritive value of Indian foods and the incidence of tuberculosis among Indians, are dealt with. Like all scientific publications, the report is technical, but is yet not without interest to the lay reader. During the year under report, further researches into other subjects of equally dreadful interest, such as cholera, malaria, leprosy, plague, cancer and snake venoms were undertaken with particular reference to Indian conditions.

* * *

The Indian Military Academy.—The main object of this institution is to foster in the cadets the qualities of leadership, discipline and physical fitness and to instil in them a high sense of duty, of honour and of patriotism. In order to secure such praiseworthy ideals, a library, a museum and extensive play-grounds are proposed to be added while every opportunity is utilised for enriching and extending the social activities of the Academy. These activities ought to humanise the young cadets, and help them to understand and behave in the proper way in societies differing from their own in customs and behaviour.

* * *

Indian Cotton and Lancashire.—The third annual report of the Lancashire Indian Committee, established by the President of the Board of Trade of Great Britain in the autumn of 1932, records with sense of satisfaction that the takings of Indian cotton by the United Kingdom in the calendar year 1936 should have passed the half million bales mark by a very satisfactory margin. This beautifully got-up document contains valuable tables regarding consumption of Indian cotton, effect of price on demand for Indian cotton, its comparative consumption, imports of raw cotton into the United Kingdom from India and imports and exports of chief commodities. The report acknowledges the indebtedness of the Lancashire Committee to the Indian Central Cotton Committee whose co-operation led to the achievement of such handsome results.

* * *

A Guide to Indian Cottons.—The East India Cotton Association, Ltd., and the Indian Central Cotton Committee, Bombay, have jointly brought out a brochure, under the title of "A Guide to Indian Cottons", with a preface by Sir Purshottamdas Thakurdas, Vice-President of the Indian Central Cotton Committee.

The need for such a brochure is widely felt by those in the Cotton trade.

In view of the fact that Indian cottons are attracting greater and greater attention in the world's markets, the 'Guide' will supply a long-felt want.

The information contained in it has the stamp of authority on it since it has been brought with the kind and full co-operation of the several commercial bodies and the various Directors of Agriculture, all over India.

The technical information given in the brochure was collected by the Technological Laboratory of the Indian Central Cotton Committee situated at Matunga.

A table of the staple length, blow room loss and spinning performance of the various growths of cotton under average mill conditions is given at the end of the book which will be found very useful.

Dealing with the characteristics of Indian cottons under Bengals, Broach, Oomras and Southerns in a detailed manner, the 'Guide' brings out the varying trade names by which they are known in different geographical districts where they are produced.

This information is bound to be very useful to the consumers of Indian cottons both in this country and abroad, in picking up cottons suitable to their particular requirements.

The get-up of the book is quite attractive and it can be had from the Secretary, Indian Central Cotton Committee, Post Box No. 1002, Bombay. It is priced 6 annas.

* * *

Timber for Development of Communication.—In a pamphlet issued by the Forest Research Institute, Dehra Dun, the possibility of employing treated timber for the construction of bridges is discussed as an important part of the rural reconstruction programme. It is claimed that as a result of intensive researches, the Institute has evolved a process of treatment which gives any kind of timber sufficient resistance to the ravages of weather and insect pests and that the impregnated wood offers excellent material for building durable railway and highway bridges. Bridge spans of 100 feet are possible with properly designed timber trusses. Spans up to 350 feet are practicable if the suspension bridge type is employed. 70 to 90 per cent. of the total length of railway bridges of several important systems of railways in the United States of America are of treated timber, and the Howe Truss Bridge at Fresnel, British Columbia, having two spans of 150 feet each and three spans of 180 feet each, is a notable example of treated timber highway bridge. The maintenance of all weather roads in the countryside is an important part of the rural development scheme in India, and easy and safe communications for the rapid transport of agricultural produce are an integral part in the promotion of village prosperity.

* * *

Education in India in 1934–35.—The quantitative increase in numbers of pupils undergoing instruction in Indian schools and colleges of all types is maintained. In 1932–33, this increase was 86,995 and in 1934, it rose to 319,358 while in 1935 it was 333,979 of whom 135,195 were girls and 198,784 boys. From tables published in the report, it will be seen that out of the total number of boys of school-going age who should be in primary schools 50·3 per cent. are enrolled while the percentage for girls is only 16·5. These figures will not satisfy the leaders of public opinion, whose ambition is that every child of whatever sex

and social status, must obtain the rudiments of education in order to take an intelligent and active interest in the civic administration and to exercise the franchise with discrimination, and generally to lead an enlightened and useful life. The report observes that "no provincial ministry since education has become a transferred subject, has had the courage to tackle the evils permanently. They could not reorganise and readjust in the higher stages of the educational system as there are too many vested interests to antagonise, while in the lower stages they have been unable to stem waste and extravagance". We are not amazed at these criticisms. In our judgment, it was the most egregious blunder to transfer education to provincial ministry and subject its portfolio to the vicissitudes of the political fortunes of party government. Commissions and conferences draw up skilful and learned reports and yet education is the favourite topic of popular criticisms. The report issued by the Government of India is something more than a mere statistical record. *Video meliora proboque, Deteriora sequor* is the motto not only of education but of so many other departments, and India has a genius for seeing and approving better things and pursuing the wrong methods and achieving indifferent results.

* * *

The National Geographic Society, Washington, U.S.A.—The Smithsonian Institution Expedition for the collection of wild animals from the Dutch East Indies, organised by the American Geographic Society, for the purpose of displaying them in the National Zoological Park in Washington, has, through the intrepid zeal of Dr. W. M. Mann and Dr. M. O. Williams, collected numerous birds and scores of mammals. Among the latter are a hog badger, a Sumatran wild dog, a lemur, a martin, a pigmy leopard cat and a baby tiger.

* * *

An ingenious device designed by Dr. Irwine Gardner of the National Bureau of Standards, by means of which the extremely faint, wispy outer portion of the pearly corona of the Sun can be made to register on a photographic plate while over-exposure of the brighter, close-in portion is avoided will be used for the first time by the U.S. Navy Solar Eclipse Expedition on 8th June. The device consists of a flat disc, portions of it cut away, which will rotate between the photographic plate and the "breech" of Dr. Gardner's telescopic camera. The rotating disc has been used in the laboratory work in light measurement, but this will be the first occasion on which it is to be employed to obtain an even exposure of the Sun's corona. The disc is 13 inches in diameter and has a rim, a hub and four blades like the petals of a flower, equally spaced over the disc. There will thus be a great deal of open space near the rim and only narrow openings near the hub. As the disc turns, it will cut out a considerable part of the bright light from the inner part of the corona and will allow all the faint light from the outer portion to get through to the photographic plate. The disc will be kept spinning before the plate by an electric motor at a speed of 100 revolutions a minute. Half the photographs of the corona to be made by Dr. Gardner will be taken with the disc in place, and half without it.

* * *

Dr. Gilbert Grosvenor, President of the National Geographic Society, U.S.A., recently announced that the remote and little-known interior of semi-tropical Kwangsi Province in South China will be explored for new scientific and geographic knowledge by a joint expedition of the National Geographic Society and Lingnan University, Canton. In the Kwangsi hinterland are both plants and people practically unknown to the outside world. This expedition will search for plant-bearing mysterious fruit, only vaguely known to Western science, but reported to be used for medicinal purposes by the Chinese. It is known as Lo Hon Kwoh or Ahern's fruit. The natural history of the region, geological formations, life and customs of the people especially of the aboriginal tribes and the significance of Kwangsi as a transition zone between the Malayan tropics and the highlands of Tibet will also be studied by the Expedition.

* * *

We congratulate **Mr. Hari Ram Sarna** who has just returned from England with a Ph.D. from the University College, London. Dr. Sarna has worked with Professors E. N. da C. Andrade, D.Sc., Ph.D., F.R.S., and A. H. Compton, two of the world's best known physicists. His work on dielectric constants and dielectric dispersion at University College, London, has been highly praised by Prof. Andrade, who speaks of Dr. Sarna as an excellent student with a very sound knowledge.

* * *

Royal Institute of Science, Bombay.—Dr. T. S. Wheeler has been elected additional Vice-President to represent the Indian Academy of Sciences on the Council of the National Institute of Sciences, India.

Mr. M. R. Kapadia will officiate as Lecturer in Physics *vice* Dr. N. R. Tawde, who is acting for Professor G. R. Paranjpe while the latter is on leave.

* * *

Indian Science Congress Association—British Association Delegation to Jubilee Meeting.—*Acceptances to date* 19–5–1937. Baily, F. G., Professor of Electrical Engineering, Heriot-Watt College, Edinburgh. Baly, E. C. C., C.B.E., F.R.S., Professor of Inorganic Chemistry, Liverpool University. Blackman, V. H., F.R.S., Professor of Botany and Director of Biological Laboratories, Imperial College, London. Caie, J. M., Assistant Secretary of the Department of Agriculture for Scotland. Debenham, F., Professor of Geography, Cambridge University. Fearnsides, W. G., F.R.S., Professor of Geology, Sheffield University. Mcfarland, J., Reader in Geography, Aberdeen University. Ogilvie, A. G., Professor of Geography, Edinburgh University. Rendle, Dr. A. B., F.R.S., Formerly Keeper of Department of Botany, British Museum (Natural History), London. Saunders, Miss E. R., Lately Lecturer in Botany, Newnham College, Cambridge. Stratton, F. J. M., Professor of Astrophysics, Cambridge University. Venn, Dr. J. A., President, Queen's College, Cambridge, and Lecturer in History

and Economics of Agriculture. Wynn Jones, Dr. Ll., Lecturer in Psychology, Leeds University. *Acceptances to date* 14–5–1937. Barker, E., Professor of Political Science, Cambridge University. Crew, F. A. E., Professor of Genetics and Director of the Animal Breeding Research Department, Edinburgh University. Howarth, O. J. R., Secretary, British Association for the Advancement of Science.

* * *

We acknowledge with thanks receipt of the following :—

"The Agricultural Gazette of New South Wales," Vol. 48, No. 5.

"Indian Journal of Agricultural Science," Vol. 7, No. 2.

"Monthly Bulletin of Agricultural Science and Practice," No. 5, May 1937.

"Journal of the Royal Society of Arts," Vol. 85, Nos. 4405–4408.

"Biochemical Journal," Vol. 31, No. 4.

"Biological Reviews," Vol. 11, Nos. 1 and 4 ; Vol. 8, Nos. 1–4 ; Vol. 9, Nos. 1–4 ; Vol. 10, Nos. 1–4.

"Journal of the Institute of Brewing," Vol. 43, No. 5.

"The Calcutta Review," Vol. 63, No. 2.

"Chemical Age," Vol. 36, Nos. 930–933.

"Journal of Chemical Physics," Vol. 5, No. 5.

"Berichte der Deutschen Chemischen Gesselschaft," Vol. 70, No. 5.

"Russian Journal of General Chemistry," Vol. 7, Nos. 3–6.

"Journal de Chemie Physique," Vol. 34, No. 3.

"Experiment Station Record," Vol. 76, No. 4.

"Transactions of the Faraday Society," Vol. 33, Part 5, No. 1.

"Indian Forest Records," Vol. 2, No. 4.

"Genetics," Vol. 22, No. 3.

"Transactions of the Mining and Geological Institute of India," Vol. 33, No. 1.

"Indian Trade Journal," Vol. 135, Nos. 1612-14.

"Bulletin of Indian Industrial Research," No. 9.

"Marriage Hygience," Vol. 3, No. 4.

"Scripta Mathematica," Vol. 4, No. 3.

"Medico-Surgical Suggestions," Vol. 6, No. 5.

"Review of Applied Micology," Vol. 16, No. 4.

"Journal of the Bombay Natural History Society," Vol. 39, No. 5.

"Nature," Vol. 139, Nos. 3521–24.

"Journal of Nutrition," Vol. 13, No. 4.

"Research and Progress," Vol. 3, No. 3.

"Canadian Journal of Research," Vol. 15, No. 4.

"Journal of Research." Vol. 18, No. 1.

"Science and Culture," Vol. 2, No. 11.

"Science Forum," Vol. 2, No. 2.

"Arkive Fur Zoologie," Band 29, Nos. 1–2.

ACADEMIES AND SOCIETIES.

The Indian Academy of Sciences:

May 1937. SECTION A.—C. DAKSHINAMURTI : *Light-Scattering, Raman Spectra and Allied Physical Properties of Some Essential and Vegetable Oils.*—The results are discussed in relation to the known chemical constitution of the various oils. R. S. KRISHNAN : *Dispersion of Depolarisation of Light-Scattering in Colloids. Part III. Platinum, Copper, Selenium and Tellurium Sols.*—These sols do not possess any region of specific absorption. The factors ρ_u and ρ_v increase towards the ultra-violet, while ρ_h decreases. The particles in these sols must have an appreciable size, spherical in shape. S. RAMA SWAMY AND K. Y. SRINIVASA IYENGAR : *X-Ray Analysis of the Structure of a Fibrous Modification of Tourmaline.*—In the fibrous modification the unit cell dimensions are same as in the unmodified core of the mineral. M. I. HAQ AND R. SAMUEL : *Note on the Absorption Spectrum of Phosphorous Pentaselenide Vapour.* R. SAMUEL AND M. USMAN : *Absorption Spectra of Solutions of Some Halides and Oxyhalides of S, Se and Te.*—The absorption spectra do not essentially differ from those obtained in the vapour state. T. VENKATARAYUDU : *On the Linear Algebra of Classes of Elements in a Finite Abelian Group.* K. C. PANDYA AND T. A. VAHIDY : *The Condensation of Aldehydes with Malonic Acid in the Presence of Organic Bases. Part VIII. The Condensations of o- and m- Methoxybenzaldehydes.*—The general expectation that the yields in the case of the condensations of the methyl ethers will be higher is abundantly fulfilled in both the cases. V. R. HEERAMANECK AND R. C. SHAH : *Tautomerism of 2-Phenyl-3-Carbethoxy-4-Hydroxy-Quinoline.*—The quinoline reacts both in the enolic and ketonic forms. R. ANANTHAKRISHNAN : *The Raman Spectra of Crystal Powders. V. Inorganic Nitrates : Water of Crystallisation.*—The complete spectrum of several nitrates are reported for the first time. The spectra of the water of crystallisation in several salts vary very much from substance to substance, both in intensity and sharpness. They are in general between 3150 and 3650 cm.[1] P. S. SRINIVASAN : *The Elastic Properties of Mother-of-pearl.*—The Young's modulus in any given direction diminishes with increasing protein content. A general expression for calculating the elastic modulus of a compound structure in terms of the elastic moduli of component materials and their distribution is derived. B. K. SINGH, K. NARAYAN, P. SINHA, S. PRASAD AND N. CHATTERJI : *The Physical Identity of Enantiomers. Part III.—Viscosities Densities and Refractivities of* d-, l- *and* dl- *forms of Isonitrosocamphor (Stable and Unstable), Camphor Camphoric Acid, Camphoric Anhydride, Camphorquinone and Sodium Camphorate.*—It is concluded that there is strong evidence for the existence of racemates in solution in all cases.

Indian Mathematical Society:

(*Journal*, 2, No. 5). E. H. NEVILLE: *Bipolar and Trigeminal Coordinates on a Line.*—If P is a variable point on a line AB, the expressions AP^2, BP^2 are called bi-polar co-ordinates. If these are called λ, μ, and if $h = AB^2$, there is a relation between λ, μ, h which can be expressed by saying that the line $\lambda x + \mu y + 1 = 0$ touches the conic $hxy + x + y = 0$. Thus a correlation is established between points on AB and the tangents to a hyperbola. This sets up a correspondence between point-pairs on the line and points in the plane of the above conic. A systematic study of this correspondence forms the subject-Matter of this paper.

MISS. S. PANKAJAM: *On Symmetric Functions of* n *Elements in a Boolean Algebra.*—If $A_1, A_2, \ldots A_n$ be elements of a Boolean Algebra, let $\beta_r(A_1, A_2, \ldots A_n)$ denote the class of elements belonging to exactly r of the classes A. These functions β_r are considered for different values of r, and various types of symmetric functions formed from the A's by the Boolean operations $+$, $\times$, negation as well as conjunction and disjunction are expressed in terms of the β's.

D. P. BANERJEE: *A Further Note on the Zero of Bessel Functions.*—It is proved that J_n and J_{n+m} have no common zeros except perhaps those at the origin, provided m and n are real,

$$|m| < 1 \text{, and } n > max\left(\tfrac{1}{2}, \frac{m^2}{2(1-m)}\right). \quad \text{fol-}$$

lows that if $|m| < 1$, and m, n be real, $Y_n(z)$ and $Y_{n+m}(z)$ have no common positive zeros except may be those at the origin.

Mathematics Student:

(*Journal*, 4, No. 3). This issue is dedicated to the memory of the late Mr. V. Ramaswamy Aiyar, the founder of the Indian Mathematical Society, and contains a portrait of his later years. Life sketches and reminiscences of this remarkable personality are given by Mr. M. T. Naraniengar, by Mr. S. R. Ranganathan, and by several other gentlemen who had the occasion to move or correspond with him frequently. There are also some articles contributed by him, and the substance of one of his lectures on the Fermat point of a three-point system delivered under the auspices of the Madras University. There is also a paper by Mr. A. A. Krishnaswami Ayyangar, entitled " Geometry of the tricusped hypo-cycloid " which was the outcome as well as the development of certain of Mr. V. Ramaswamy Aiyar's results in the subject. Lastly, solutions to several problems of V. Ramaswamy Aiyar, and some new of his in connection with what he ha the *Durai Rajan point* of a quadra published.

V. RAMASWAMY AIYAR: *The Ferm of a Three-Point System.*—If A, B, C points, the position (or positions) of P the expression λ PA $+ \mu$ PB $+ \nu$ PC is a is the Fermat point (or points) of th The problem is to study the position or of the Fermat points for varying valu constants λ, μ, ν. A geometrical stud problem is explained here, with p reference to the cases where λ, μ, ν are all

V. RAMASWAMY AIYAR: *Note on a Curves.*—Let R_{2n} be a curve of class n + ing the line at infinity n times, the circul being two of the points of contact. T is determined when $2n$ tangents are giv have then the property:

If any $2n + 1$ tangents of an R_{2n} b their Clifford-Miquel circle is a straigh

When $n = 2$, this gives: If any five tangents to a three-cusped hypo-cyclo Miquel circle becomes a straight lin earlier by the author in Question 1250, *J*

A. A. KRISHNASWAMI AYYANGAR: *of the Tri-Cusped Hypo-Cycloid.*—Am several results, the following may be m here:—

(1) If any transversal cut the sides AB of a triangle ABC at D, E, F, su BC.BD + CA.CE + AB.AF = Ω (a c (the segments being taken positively direction which makes the area of the positive), then the transversal envelope tri-cusp inscribed in the triangle AB 1458, *J.I.M.S.*).

Conversely, if ABC be any triangle scribed to a tri-cusp, and any tangent tri-cusp meet BC, CA, AB in D, E, BC.BD + CA.CE + AB.AF is constant

(2) If P_1, P_2, P_3 be the points of inte of any tangent to a tri-cusp with three co tangents OT_1, OT_2, OT_3 whose points of are T_1, T_2, T_3 then

$$\Sigma \frac{OP_1}{OT_1} = 1 \text{ and } \Sigma \frac{1}{OP_1 \cdot OT_1} = 0$$

(3) If the tangents at T_1, T_2, T_3 to a meet in O, the isogonal conjugate of the angle T_1OT_2 bisects T_1T_2 and is to the other tangent from T_3.

(4) Tangent pairs from points on an tangent to a tri-cusp meet the line at in point-pairs of the same involution, o the circular points are members. The points of the involution are the points at on the tangents at the extremities of the chord.

Erratum.

Vol. 5, No. 11, May 1937, page 595 article entitled " A Note on the Hairiness Punjab Cottons ".—

In place of " By R. S. Jai Chand Luthra "

read " By R. S. Jai Chand Luthra and Indar Singh Chima ".

986-37.—Printed at The Bangalore Press, Bangalore City. by G. Srinivasa Rao, Superintendent, and Published by B. N. Sastri, M.Sc., A.I.C., A.I.I.Sc., for the " Current Science " Board of Editors, Indian Institute of Science, Hebbal Post, Ban

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